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Climatic Effects of the Proposed Wooded Shelter Belt in the Great Plains

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In the summer of 1934 it was announced that the Federal Government was promptly to plant a "shelter belt" which would extend from the Canadian boundary to northern Texas near the western margin of the region where general farming is practicable. This announcement aroused great interest in all sections of the country, especially because it was claimed that the proposed belt of woodland would conspicuously alter the climate, increasing the rainfall. The section that the belt would cross was at the time experiencing a severe drouth, and even the eastern States were much impressed by a great dust storm in the springs of 1934 and 1935, the dust for which came largely from the general region of the proposed tree belt.

The planting of the billions of trees contemplated was to be done, under the direction of the United States Forest Service, by men in need of relief. The project, indeed, to be a great "relief job" which was to have long continued value.

Comptroller McCarl ruled in September 1934, however, that as the planting of the trees would necessarily be extended over several years because nursery stock was not available, the financing of the project could only be started with the funds appropriated by Congress in the previous spring for immediate relief of the people of the drought-stricken States. This ruling restricting the available funds led to a sharp curtailment in the program. However, with the million dollars still available, the program

is proceeding at a slower pace, with the expectation that a continuing appropriation will be granted by the next Congress.

The delay caused by Comptroller McCarl's ruling affords time for a more careful consideration of the question. A number of thoughtful articles have been published recently, for example, by Editor Ovid Butler in *American Forests* for September, by Ellsworth Huntington of Yale University in *Journal of Forests* for November, and by Experiment Station Director L. R. Waldron in *The Country Gentleman* for November. *American Forests* has also presented in its November and December issues expressions of opinion by several qualified men as to the feasibility of the project from the viewpoint of the forester.

Each of these three articles and several of the opinions question the soundness of the sweeping claims that the proposed shelter belt would modify the climate to any great extent. Their main attention is paid, however, to the problem as to whether the project could be successfully carried out—would the trees grow, without an unreasonable expenditure of money?

The following discussion is concerned chiefly with the probable climatic effects of the proposed belt. It is written by one who has spent years within the proposed zone and several additional years a few miles east of it. The especial basis for its discussion is, however, a somewhat extended study of the influences affecting climate of the past and present (*Climate Changes, their Nature and Causes*, co-author, Yale University Press, 1922; and *Climatic Laws*, John Wiley and Sons, 1924).

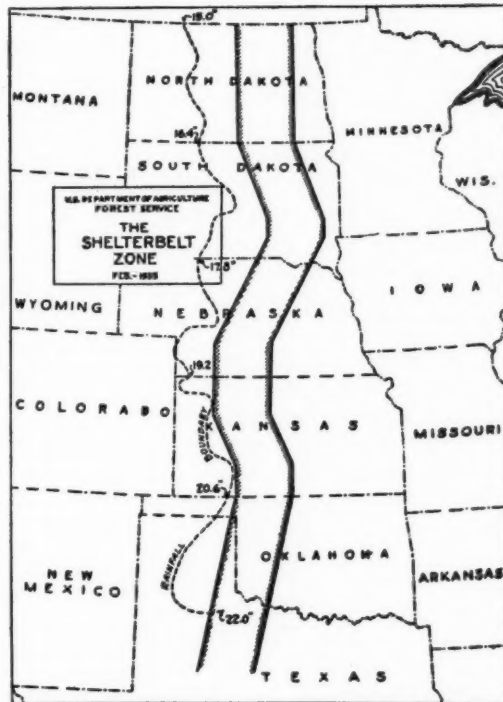
PRESENT CLIMATIC CONDITIONS

As a background for a consideration of possible future changes of climate, a summary of the present climate is advantageous.¹ The proposed shelter belt is to be 1000 miles long and 100 miles wide, located in the region where the average annual rainfall ranges from about 19 inches at the north to about 23 inches at the south (Fig. 1).

Much of the precipitation falls during the warmer months, about 9 inches in an average summer (three months) at the north and almost 10 inches at the south. The rate of evaporation increases southward rather sharply, the daily average being almost twice as great during the frost-free season at the south as at the north. Hence, the soil is relatively drier at the south than at the north, on the average. The amount of snow which falls varies in an average year from about 30 inches at the Canadian boundary to about 15 inches in the Panhandle of Texas. The contrast in the

¹Cf. United States Department of Agriculture: *Atlas of American Agriculture*, Pt. II, *Climate*. Washington: Govt. Ptg. Office, 1918-28.

FIG. 1—The shelterbelt zone as revised in 1935. Note that the annual rainfall line shown is not an isohyet, but ranges from 15 inches on the Canadian boundary to 22 inches in Texas.



duration of snow-cover is very much greater, however, being more than 120 days at the north as compared with about 20 days at the south. The average temperature during the three winter months ranges from 5° F. at the north to 35° F. at the south. During the summer, however, the contrast is much less, between about 64° and 76° respectively. This region is the windiest in the United States during the afternoon hours, when the average velocity is approximately 15 miles an hour or about 50 per cent higher than that for most of the country. Including both day and night, the wind velocity in the region averages close to 12 miles an hour and is likewise about 50 per cent higher than most of the country. During July the winds blow predominantly from the south or southeast, while in January northwest winds predominate.

PRESENT VEGETATION AND AGRICULTURE

So far as trees or agriculture is concerned, average conditions are far less significant than extremes. This region is one of sharp contrast in

the amount of rainfall. Drouths of 60 days duration during the frost-free season are of frequent occurrence throughout the proposed shelter belt. Moreover, severe drouths of many months duration are common enough to make farming very much of a gamble here, and to limit the native vegetation to plants which do not require regular supplies of water.

The belt was originally located near the margin of the short grass type of vegetation, which type is characteristic of its entire width at the south and in South Dakota, and of the western part of the belt in the other states except Nebraska and northern North Dakota where the belt is in the western margin of the tall grass type. The proposed location was changed as a result of protests, and in Feb., 1935, the belt was mapped as lying entirely within the tall grass type of vegetation. This means that it was shifted eastward substantially, reaching its most easterly point in South Dakota, within 25 miles of northwestern Iowa (Fig. 1). This eastward shift increases greatly the prospects that trees can be induced to grow. Native trees are almost entirely lacking in this belt except in a few valleys where the roots can reach ground water, or where there is some protection from the dessicating winds.

To the east of the proposed belt there are numerous groves of trees most of which were planted during the period (1874-1891) when Tree Claim Homesteads were given free for growing ten acres of trees. As the proposed shelter belt is approached, however, such groves become few and mostly sad-looking affairs; many of them have been killed by the drouth of the last few years.

Agriculturally, the area of the proposed shelter belt has been put under the plow extensively, especially in North Dakota, northern South Dakota and Kansas, being devoted largely to wheat. When wheat is relatively high priced, farming may be a fair gamble in this belt, but when wheat prices are normal, even superior farmers on exceptionally favored farms have difficulty making a fair living by farming. This region is naturally adapted to stock raising, the nutritious grasses, small amounts of snow-cover, and reasonable accessibility to a market in the corn belt at the east, all being favorable to the raising of livestock.

THE PLAN OF THE SHELTER BELT

The proposed shelter belt is to consist of one hundred narrow north-south bands of woodland, each seven rods wide, separated by nearly a mile of farmland. The trees selected vary with the latitude, being chiefly green ash, hackberry, and the Chinese elm, supplemented toward the south with the honey locust and osage. All are small, slow-growing trees, and decades are required for them to become mature, and then they are usually

only 30 to 40 feet tall. Such rapidly growing trees as the cottonwood have been found unsatisfactory in the area to the east because of their short lives and brittle wood, although they attain much greater heights. However, the revised plan calls for some cottonwoods in the central section of the belt.

Although the worst "hot winds" are often from the southwest, several writers on the subject have pointed out that east-west bands of woodland would afford more "shelter belt protection" in this region than would the proposed north-south bands because the north-south component of the winds is greater than is the east-west.

The announced location of the strips of woods is significant in another way also. It is proposed that the strips extend halfway between the north-south section lines, along the interfarm line. Since the main roads follow the section lines, and most of the homes are close to the roads, the proposed location would mean that the trees would be nearly a half mile from most of the homes, and hence would not be directly beneficial as affording windbreaks for farmsteads. Presumably the proposed location was chosen to reduce the blocking of the roads by snow drifts which often gather in the lee of the trees in this windy region.

UNDOUBTED CLIMATIC EFFECTS

The influence of even small trees upon local windiness is conspicuous in the grassy plains. Hundreds of thousands of groves have been planted in the naturally grassed-over region to the east of the proposed shelter belt, and their beneficial effects in reducing the chilling effect of winter winds and in reducing the scorching from hot dry winds of summer are conspicuous immediately to their leeward.

Similar windbreaks have been planted extensively in other grassy regions which are humid enough to support trees, as in parts of Russia, Argentina, and prairie Canada. The effects of these groves in reducing the scorching from hot winds often leads to much better crop yields near the groves than at a little distance, but is usually chiefly confined to a strip a few rods wide to the leeward. Some careful studies by the United States Forest Service (Bulletin 86) found that most of the benefit was confined to a strip about twenty times as wide as the trees were tall. In winter the cold winds are conspicuously reduced in a narrow strip too, its width depending upon the character of woody growth, its height, the lay of the land, and the strength of the wind.

Experience with the planted groves in the general region of the proposed shelter belt indicates clearly that on the average the wind velocity would be little affected, except very locally, by north-south strips of woodland nearly a mile apart. If, in addition, there were east-west strips a mile

apart, doubling the amount of trees to be planted and cared for, the sheltering effect would be greatly increased, partly because many of the winds are from northerly or southerly directions rather than westerly or easterly. Such a density of trees would, nevertheless, unquestionably be inadequate to shield most of the farm land from scorching winds. One competent writer on the subject believes that the strips of woodland would need to be only one-tenth of a mile apart, instead of a mile, in order to afford much shelter to the crops. But such small fields would interfere critically with the use of the farm machinery required in the extensive type of farming best adapted to that region.

The effect of the groves on the distribution of a snow would occasionally be very conspicuous in parts of the region. Instead of being drifted by the wind for miles, as it often is now, coming to rest in great drifts in stream valleys or other depressions, much more snow would accumulate near where it fell, among the trees and in the lee of the nearest grove. The beneficial effects of the snow water in moistening the ground of the uplands would hence be increased. But as the total snowfall of this region is equivalent to only about two or three inches of rainfall, and much of this snow is too wet to drift, the effect of the shelter belt upon increasing soil moisture by affecting the drifting of the snow is likely to be over-estimated.

Any reduction in average wind velocity which the trees would cause would tend to raise slightly the local surface temperatures in both summer and winter. Hence, convection currents, the raising of the heated air and the down draft of cooler air from above, would be increased. This "knitting" together of the surface layers with the overlying faster moving layers would retard wind velocity even far above the tops of the trees. An increased number of dust whirlwinds would be an obvious result of the surface stagnation caused by the groves. But a slight slowing up of the eastward movement of the cyclonic disturbances, the "lows" and "highs" of the weather map would also take place. As lows and highs cause our changes of weather and as the lows which do not pass too quickly induce much of our rainfall, any influence affecting them is significant.

HOW MUCH DO FORESTS INCREASE THE RAINFALL?

Since Jesus stated, "The wind bloweth where it listeth," much progress has been made towards an understanding of the factors affecting the weather. Most of the main influences are understood, but great uncertainty remains as to the part played by the character of the earth's surface on a plain. The effect of forests on rainfall has been much discussed, and various students of the subject have concluded that forests characteristically cause an increase in rainfall. Some, for example the English climatologist,

C. E. P. Brooks, and Dr. R. Zon, technical advisor of the proposed project, have concluded that forests increase the rainfall a definite percentage. Brooks states 5 to 10 per cent.² Dr. Zon's study³ leads him to estimate, according to the newspapers, that the proposed shelter belt will increase the water supply of the area by three inches, which means more than 14 per cent. Other investigators are doubtful of the validity of the evidence offered.

Evidences that are considered by some to prove that forests increase rainfall may be briefly summarized:

(1) In Germany and France there is slightly more rainfall in certain forested areas than in open areas not far away. However, most of the forested areas are on higher or rougher terrain and the difference in rainfall may not be due to the forest. In some cases, the slightly greater rainfall may be due to a more complete "catch" of the rainfall by the rain gauges, due to less windiness in the forest.

(2) On some otherwise quite similar mountain slopes, forested areas have more rainfall than cleared areas. This would logically follow where the condensation point had been reached as a result of the wind blowing up the slope. The forested area would often be a little cooler than the treeless area, and wind movement would be retarded by the forest, with the result that somewhat more precipitation would occur. But it would be entirely unwarranted to conclude that therefore forests on plains increase the local rainfall a corresponding percentage.

(3) A third sort of evidence offered to show that forests increase rainfall is that certain regions which have been burned over have suffered a decline in rainfall. The extensive fire may, quite likely, however, have been made possible by a decline in the rainfall which commenced before the fire occurred and which continued for some time afterwards. Certainly "the strong evidence" of the sharp fall in rainfall following deforestation by fire cited by Blanford⁴ from India is doubtful.

(4) Numerous data are available which suggest that the average rainfall has declined in certain areas after deforestation by lumbering. Careful students of climatology insist, however, that the records showing a decline are not long enough to be adequate to compensate for secular trends not due to the forests.⁵

² Brooks, C. E. P.: "The Influence of Forests on Rainfall," *Quar. Jour. Royal Meteorological Soc.*, LIV (1928), 1-18.

³ Zon, Raphael: *Forests and Water in the Light of Scientific Investigation*. United States Forest Service, Washington, 1927.

⁴ Blanford, H. F.: "Influence of the Indian Forests on Rainfall," *Jour. Asiatic Soc.*, LXI (1887), 1-15.

⁵ These include the following:

Hann, J.: *Handbook of Climatology*, 192-97. (1903).

Henry, A. J.: *Monthly Weather Rev., Supplement 17*, 1922.

Quayle, T. E.: in *Proc. Royal Soc. of Victoria*, XXXIII (1921).

(5) When the American prairies were dotted with windbreak groves and tree claims during the 1870's and 1880's, many people were confident that an increase in rainfall resulted. A similar optimistic attitude prevailed in parts of European Russia during the period of extensive windbreak planting in the three decades preceding 1914. In America, however, the theory that groves planted in the prairies caused notable increase in rainfall has been discredited in much of the area by the severe drouths which followed. Hence, Americans who claim that tree planting increases rainfall cite the Russian claims and do not mention the American experience.

Claims that the Russian shelter belt increased the rainfall there were repeatedly made in the American newspapers this past summer, inspired by persons advocating the proposed shelter belt. It is worth while to examine the evidence as to the reasonableness of these claims.

Rainfall varies from year to year throughout the world and the range of variation is conspicuously large in the drier regions such as the Great Plains. In addition to erratic variation from year to year, there are cyclic variations of considerable magnitude.⁶ During years of increasing rainfall, various explanations are offered as the cause of the increase. For example, from 1894 to 1909 rainfall on the average was distinctly greater in the Dakotas than it had been in the decade preceding. This was attributed by some persons to the extension of barbwire fences; by others to the increased cultivation of land, or to the drilling of artesian wells. Conversely, dry spells have been attributed to deforestation, to the draining of land, and even to radio broadcasting.

The rainfall of southern European Russia is even more erratic than that of central Kansas and Dakota. The wetter periods have, it is true, been attributed by some writers to the windbreaks, but no climatologist of standing has presented evidence in support of this claim. Indeed, from a scientific point of view the Russian "evidence" is woefully inadequate.

CYCLES OF RAINFALL

The evidence that there are cyclic variations of rainfall in many regions has accumulated until it is now widely accepted as adequate to prove the

⁶ For further information the following references may be consulted:

Visher, S. S.: "The Climate of South Dakota," *South Dakota Geol. Surv. Bull.* 8 (1918), 50-67.

Kincer, J. B.: "The Climate of the Great Plains," *Annals Assn. Amer. Geogrs.*, XV (1923), 67-80.

Mattice, W. A.: "Precipitation in the Great Plains," *Monthly Weather Rev.*, LXII (1934), 445-7.

Bowman, I.: "Our Expanding and Contracting 'Desert,'" *Geog. Rev.*, XXV (1935), 43-61.

Joerg, W. L. G.: "Geography and National Planning," *ibid.*, 180-3.

existence of cycles. Many efforts have been made to discover the causes of these cycles, but without much success. Some of the variations appear related to the solar cycles, but the cause of most variation is still unknown.

There has been a declining average rainfall during the last seventy-five years or longer in an extensive area centering about St. Paul, Minnesota.⁷ During this period, part of this region has been deforested, while in a zone to the west and south of the deforested area, hundreds of thousands of groves have been planted, and throughout the drier half of the whole area experiencing declining average rainfall, hundreds of millions of acres of what formerly was grassland have been put under cultivation.

These three significant environmental changes—deforestation toward the northeast, planting of groves, and cultivation of former grasslands—all involve vastly larger acreages than the proposed narrow band of trees, as the total area to be planted with trees in the shelter belt is no larger than a single large county in Minnesota (1,500,000 acres). Moreover, these changes are of a sort more likely to modify the climate. Yet the decline in rainfall is by no means clearly related to these changes. This is shown in various ways. For example, while the rainfall has been declining conspicuously in eastern Minnesota and adjacent areas which have been deforested, it has contrariwise been increasing in parts of the southeastern section of our country, where deforestation has likewise occurred. Similarly a decline has occurred in Iowa and eastern Dakota where many groves were planted, but the amount of the decline varies with the distance from St. Paul, not with the number of groves. Indeed, south of Kansas there has been an increase in average rainfall, while in Kansas there have been a number of sharp oscillations during the last 75 years. And again, the prairie provinces of Canada and vast grassy areas in eastern Argentina have been put under cultivation in recent decades and have also had changes in average rainfall, but these two regions have had opposite trends in average rainfall, increasing in the Pampa of Uruguay and Argentina and decreasing in Prairie Canada.

POSSIBLE CLIMATIC EFFECTS

There are two scientific ways of studying such a problem as the effects on precipitation of a zone of trees in a short-grass plains region. One is to keep rainfall records long enough to see what changes have followed the planting of shelter belts. In regions of such erratic rainfall as the sub-marginal zones under consideration, rainfall records would need to be

⁷ Kincer, J. B.: "Is Our Climate Changing?," *Monthly Weather Rev.*, LXI (1933), 251-9.

Pack, D. A.: "Significant Changes in Rainfall," *ibid.*, 345-9.

gathered at many points over many decades both before and after the trees were planted, in order to be adequate to prove the effect of the groves.

In the absence of adequate rainfall records, the problem may be attacked by the deductive method; a consideration of the causes of rainfall, and what effects would logically follow from the changes in the local environment which the bands of trees would produce.

The rains of the grassy plains region of the United States are predominantly convectional showers associated with the eastward moving cyclonic lows during the warmer months. Drouths occur whenever lows are lacking, or when they pass at considerable distance, or when they pass too rapidly, or whenever they are too feeble to cause adequate convectional overturning. This last, the rapid extensive rising of moisture-laden air, is necessary in order to cool it sufficiently in this dry belt so that supersaturation will occur, and precipitation result.

The proposed wooded belt would, by increasing friction, slightly retard the eastward movement of the lows. But this retardation would presumably be too slight to produce any significant increase in rainfall from this cause. Moreover any increase that was caused would fall almost exclusively to the east of the shelter belt.

The barrier effect of the belt of trees in causing the air of rain-bearing winds to rise, thus inducing convectional overturning favorable to rainfall, is greatly lessened by the fact that the rain-bearing winds of this region are from the southeast, not over the treeless plains to the west. Since the proposed shelter belt is just west of the zone possessing many farmstead windbreaks, such southeast winds blow over wide areas possessing many groves of far taller trees than those of proposed belt, and hence more likely to cause the air to rise. The barrier effect of the proposed belt of trees on westerly winds is of negligible importance so far as rainfall is concerned because westerly winds in this region are too dry to yield much, if any, rainfall.

The evaporation from the leaves of the trees would increase the atmospheric moisture, but this increase would occur chiefly when dry westerly winds prevail, when conditions are highly unfavorable for rainfall. Moreover, the drouth-resisting trees to be planted in the proposed woodland belt yield much less atmospheric moisture than rapidly growing grains, for example.

The belt of woodland would cause slightly lower average spring and early summer temperatures by delaying the melting of snow and the drying of the soil by shading a part of the ground. However, as only about two per cent of the land in this 100-mile belt is to be planted to trees, the shading would be very limited. The effect of the tree barrier in decreasing the ingress of warmth brought by warm southerly winds would also slightly

retard the warming of the area in the spring and early summer. This slightly lower temperature would interfere slightly with the development of the lower than average air pressures characteristic of continental interiors in summer. The source of the rainfall of this region is from moisture drawn in from the Gulf of Mexico by winds part of which result from the lower air pressures which develop in this region when it is comparatively warm, for its latitude. Although nearly all of the precipitation is induced by passing cyclonic lows, these can yield no precipitation unless the moisture is there ready to be precipitated, and other conditions are favorable. This is proved by the fact that this region receives very little precipitation in the colder months although cyclonic disturbances are more numerous and stronger then than in summer.

Hence, it is by no means clear that the shelter belt would yield an increased rainfall. Indeed, the somewhat lower average temperatures which it would cause in spring and summer logically would slightly decrease the rainfall during these important seasons. But as practically all of the rainfall is due to conditions that such belts of small trees could not significantly modify, the effect of the proposed shelter belt on rainfall would apparently be very slight, perhaps negligible.

The reduction of windiness would be beneficial but appreciable only very locally, in the groves and for a few rods to the leeward. The improvement in crop yields and in reducing the blowing away of the soil would at times be considerable just to the leeward of the groves, but almost nil elsewhere in the belt. It appears, therefore, that the shelter belt would not produce the improvement of climate claimed for it by the advocates, and that climatically it is not justified.

*Indiana University,
May, 1935.*



On the Merits of Regional Diagrams in Field Reports

With an Illustration¹

RALPH H. BROWN

No one will disagree in principle with the conclusion of a recent contributor that "of the various forms of record employed by geographers . . . the map ranks first as a device for showing the areal extent and pattern of distribution of phenomena."² Nevertheless, one occasionally reads and frequently hears adverse criticism of published field maps, especially of those maps accompanying studies of the so-called "small region." This criticism, issuing from many quarters, indicates that the map by itself does not always reveal to others, even to those presumably skilled in map interpretation, the essential qualities—areal extent and pattern—of a particular landscape.

Condemnations of the "landscape type" of map generally involve one or both of two ideas. First, it is claimed, the maps are altogether too detailed. This objection has been stated by Davis as follows: "many detailed maps designed to present facts of land occupance compactly and clearly, accomplish only the first of these two objectives."³ Second, it is frequently maintained, such maps have limited comparative value. Comments often registered on this score are that maps published by different workers in regions presumably similar and even those authored by the same worker in different studies bear but few family resemblances.

THE VALUE OF DETAILED MAPS

A solution which has been suggested for the first difficulty is the "generalized map." Authors of field maps thus condemned will reply that however detailed their depictions may appear to others their published maps, at least those of considerable coverage, are generalized to the extent deemed consistent with accuracy. The evolution of the majority of final

¹ The field work upon which this study is largely based was made possible by funds granted by the Rockefeller Foundation through the University of Minnesota.

² Jones, Wellington D., "Procedures in investigating human occupance of a region," *Annals of the Association of American Geographers*, 24 (1934), 105.

³ Davis, D. H., "Type occupance patterns of Hokkaido," *ibid.*, 223.

maps from field plats and notes involves the outright elimination and suppression of many collected data. This is necessary in order to produce a map suitable in scale and size for reproduction on a book or magazine page. Uppermost in the mind of its author is a map readily verifiable in the field, a map which will possess permanent historical value. If this essential requirement is met, then the map provides a substantial basis for comparison with a similar map of the same area constructed at a later time. The requirement of the reader for the moment has been considered as a secondary, not as a primary, objective. Having executed a map which will withstand stringent tests of accuracy, the author has depended upon generalizations afforded by the written word together with well selected photographs to bring a certain degree of order out of what to the casual map-reader may appear chaos. The further generalization of detailed maps of comparatively small regions is not, in the writer's opinion, the proper solution to the dilemma. Such maps must continue to be detailed else they will be robbed of their ultimate value in studies of sequent occupation.

The second objection, that the "landscape" maps have limited comparative value, arises chiefly from the lack of standardized conventions for many data considered essential of inclusion upon them. Color over-prints would certainly enhance the utility of these maps, but in bringing one to publication this possibility must ordinarily be disregarded, thus throwing an increased burden upon map conventions which accumulate with astonishing rapidity. So soon as standard conventions are agreed upon, the synthesis of various detailed maps of type regions will become a possibility. Apparently, however, that goal lies far in the future.

THE RÔLE OF THE REGIONAL DIAGRAM

Assuming that, at the completion of a careful field study, the investigator is reluctant further to generalize a map which he regards as already generalized, and yet considers it desirable to present to others a simplified view of the area covered by the map, there can be brought into use the "regional diagram." The regional diagram has for its chief aim the generalized and simplified portrayal of the dominant natural and cultural features and, of course, their relation to each other. When used in conjunction with the map from which it is drawn, the regional diagram provides a suitable introduction to, or summary of, a carefully worked out regional analysis. Because of its inherent simplicity it may awaken in the reader an interest which might otherwise be lacking. Unencumbered by detail, the diagram carries a message directly to the eye and leaves a visual impression upon the mind of the reader. Consequently, a well executed diagram may reduce the need of certain photographs and of lengthy verbal

descriptions. If a block forms the base of the diagram, significant underlying structure may be indicated and thus aid in the interpretation of the surface form and phenomena. Perhaps most important of all their advantages is the possibility of their use as generalized type maps in the manner suggested by Brunhes.⁴ In this way they can be employed to illustrate the dominant features of the general region of which the mapped area is only a small part, and of other regions of broadly similar character.

In transferring the actual map to the regional diagram the geographer, after having carefully weighed all the evidence as revealed by his field data, exercises his final judgment as to how much additional material can safely be eliminated the more clearly to portray that which he has found to be really significant and impossible of omission. In taking this final cartographic step the geographer clearly assumes a responsibility; quite possibly also he performs a duty, both of which properly belong to his field and function. The resulting diagram becomes a device in the attainment of an objective not often, it is to be feared, realized from detailed maps, that is, to present to others an interesting, clean-cut and unconfused picture of a region with which he has himself become intimately familiar.

A MAP AND A REGIONAL DIAGRAM OF A BIG HORN MOUNTAIN PIEDMONT

A LAND OCCUPANCE MAP OF THE BUFFALO SECTION

Figure 1 is a recently constructed land occupance map of the Buffalo section of the Big Horn Mountain piedmont in northern Wyoming. The principal purpose of the map, as indicated by its subtitle, is to provide an accurate record of the occupied area which in this instance coincides with the limits of irrigation.

The map meets the fundamental requirements of any map of its type in that it (a) shows accurately the distribution of the occupied area and (b) indicates the cultural pattern of that area in the detail consistent with its scale and manner of reproduction. The first requirement is met by confining all conventions of land occupance to the irrigated area, the second by differentiation of the irrigated land uses into six types. The land uses are those of the summer of 1934; nevertheless the pattern is representative of that of any season. Land used for pasture and that ruined by seepage is reasonably permanent and the majority of field boundaries indicated correspond with stable features: roads, irrigation ditches and property lines. The map here reproduced is the product of the usual evolution of published land occupance maps. The field plats and notes from which Figure 1 is

⁴ Brunhes, Jean: *Human Geography*, 454. Chicago, Rand McNally, 1920.

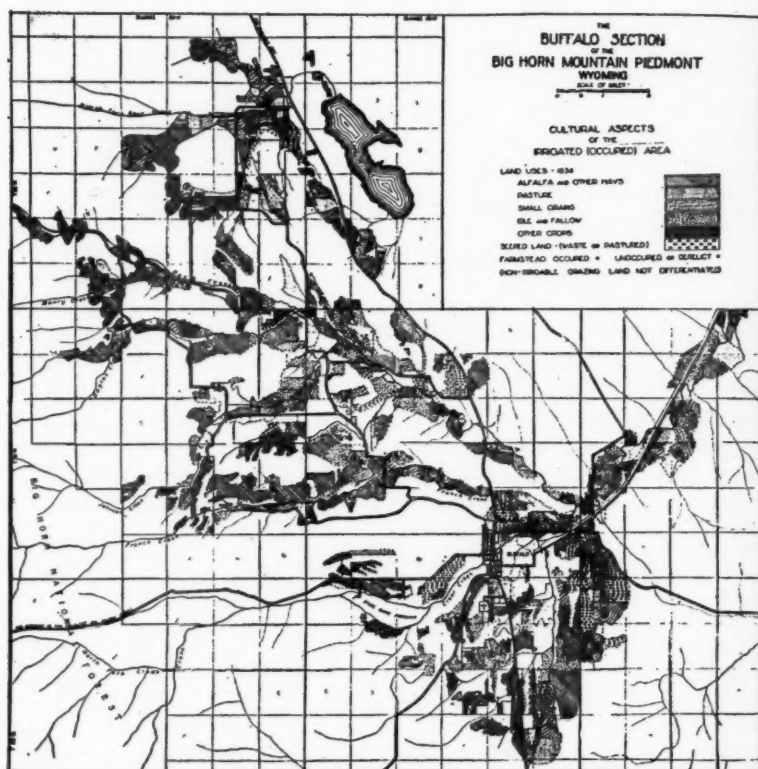


FIG. 1—Map of Land Occupance.

drawn show the pattern in greater detail but the reduction in scale from 1:1000 to 1:10,000 necessitated the exclusion of many data actually collected in the field.

Despite this suppression of data and despite also its considerable coverage (about 200 square miles) the map will probably be classified, more or less perfunctorily, as "detailed." It will also be recognized as possessing at least some of the merits as well as many of the shortcomings inherent in all maps accompanying the chorographic type of field study. The map will possibly be of some interest to certain groups of professional geographers; it will surely be of interest to the residents of the mapped area and as a record of the present it may have some documentary value for future comparative studies of land occupance.

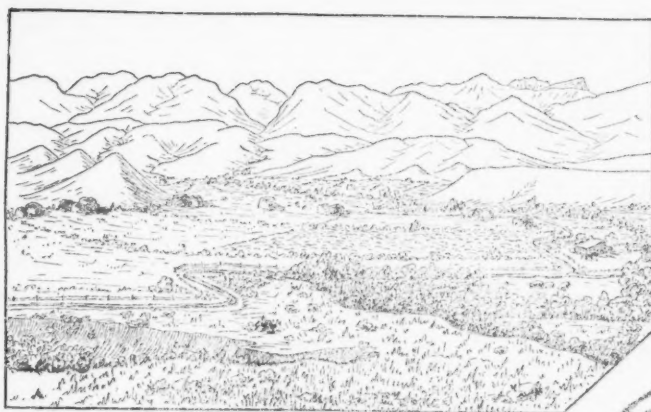


Fig 3. Field sketch of a typical landscape in the Buffalo region, looking mountainward up the valley of Rock Creek. Fore-ground: wooded flood lands and cut bank; middle distance: irrigated low lands flanked by gravel-capped benches; far distance: the Big Horns. Drawing made with aid of sketching screen.

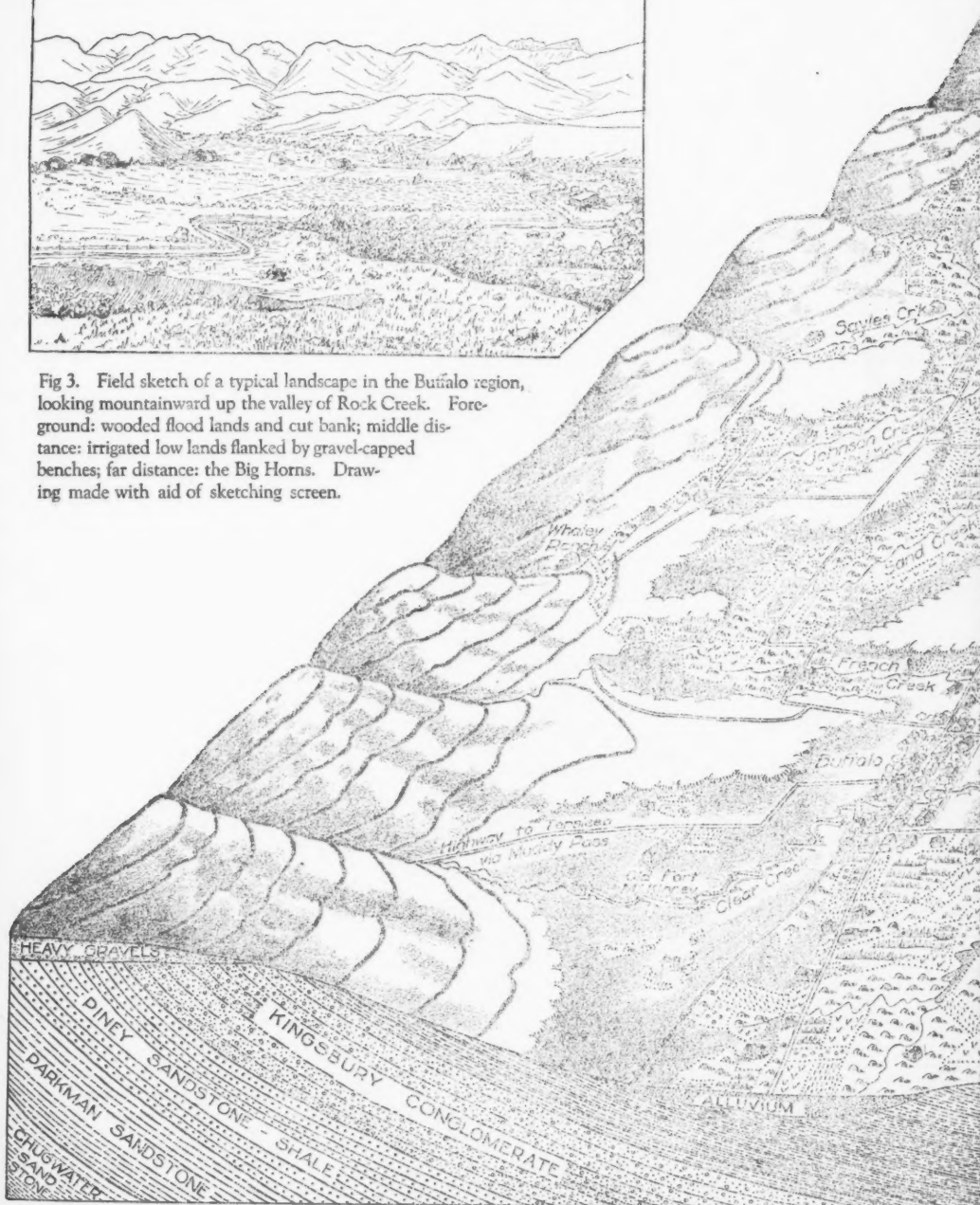


FIG 2: A regional diagram of the Buffalo section Big Horn Mountain piedmont, Wyoming

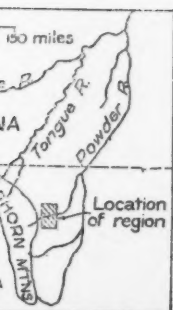
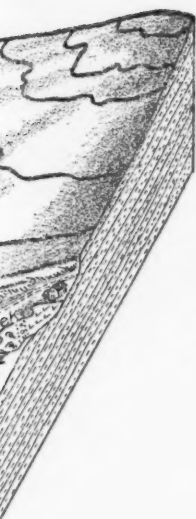
Cultural landscape
delineations :

Hay fields

Small grains

Pasture

Idle land



Quite as surely, however, Figure 1 by itself leaves much to be desired. For example, the map gives no direct suggestion as to the character of the unoccupied area. Nor, detailed though it be, does it present a complete picture of the irrigated area. What determines the limits of the occupied area? Are all the blank spaces elevated above the irrigated land? If so, how much? If the map contained the information necessary to an understanding of these and many similar questions, it would be so overburdened with material as to be practically worthless. It is obvious that the full utility of Figure 1 would not be apparent unless it were supported by one or more other maps each showing one or at least a limited number of special features. Above all there is needed a map which will portray surface configuration. Granted such an array of maps there would still devolve upon the author the necessity of fitting them all together into a coherent pattern. This would require lengthy verbal descriptions and explanations only in part made more intelligible to the reader by well selected photographs.

A REGIONAL DIAGRAM OF THE SAME AREA

1. *The Natural Landscape*

Figure 2 is a regional diagram of the same area.⁵ Attention is first called to the block base which represents pictorially and with some exaggeration of pertinent features the regional landscape as if seen in perspective. The region displays those qualities of landscape which readily lend themselves to portrayal by the block type of diagram, these especially: the spectacular setting at the base of a mountain system justly famed for its massive boldness, the linear arrangement of the "foot-hills" rising abruptly from a narrow piedmont lowland, the essential simplicity of the terrace-like benches which dominate the local scene, the direct relation of surface form to underlying structure as elaborated elsewhere by Darton⁶ and, last but not least, the clean-cut relationships between natural and cultural landscapes.

Form lines corresponding roughly with contours suggest the character of the higher slopes five to six miles west of Buffalo. The suggested con-

⁵ At various stages in the construction of the diagram, Dr. A. K. Lobeck advanced numerous constructive criticisms and valuable suggestions looking toward its further improvement. Without this aid the present diagram would scarcely have been possible, but the author is alone responsible for such imperfections as the drawing may still possess. Dr. Lobeck's suggestions included specifically: the modification of an isometric block base at first attempted, the choice of symbols for representing the cultural landscape, and various techniques in landscape portrayal. Ivan Doseff, of the University of Minnesota, also aided in the latter problem.

⁶ U. S. G. S.: *Folio 142, Fort McKinney and Cloud Peak Quadrangles*. The structure section is adapted from those appearing in this folio.

tinuity of these higher slopes as seen in profile in the more distant parts of the block and in relief along its western edge, indicate that they are in reality remnants of an ancient piedmont surface which originally sloped gently to the east. This concept is further supported by the structure-section which reveals the gravel-capped nature of Bald Ridge. This surface is now deeply dissected by Clear Creek and its numerous tributaries, all affluents of Powder River. As shown by the near edge of the block, this slope is now concave, stream erosion having removed much of the detrital overburden from the weak de Smet formation which latter now lies largely exposed. In the trough of the excavated area this formation is covered with a thin veneer of alluvium laid down by post-glacial streams. The profile formed by the near edge of the block shows that the regional slope to the east is fundamentally a dip slope determined by the underlying sedimentaries. Westward of Buffalo these formations dip with increasing steepness finally to culminate beyond the diagrammed area in magnificent hogback ridges variegated in coloring. These ridges properly mark the western limit of the piedmont and announce the immediate presence of the rugged Big Horns.

The smooth concave profile of the near edge gives way in the central part of the diagram to steep-sided, tabular benches whose flat tops are inclined in conformity with the general regional slope. Mountainward, the sharp edges of these benches merge imperceptibly; eastward they become more distinct and separate, characteristically rising as islands above narrow, stream-gouged valleys, thus maintaining high relief outward from the mountain front. A typical example is the triangular-shaped bench lying between Clear and French Creeks.

2. *The Cultural Landscape*

The block having been constructed with the results as shown and described, the next step was to transfer to it the cultural data mapped in Figure 1. This transference necessitated considerable generalization, for exactness is not possible nor even desirable in a diagram of this sort. In transferring the cultural data from the map to the block base, it seemed desirable to adhere to Brunhes's dictum that there be no alteration of the essential field relations. Essential field relations in this instance were grouped into three categories arranged in descending order of magnitude.

Elements of the First Magnitude.—First and foremost was the dovetailing of the occupied and unoccupied areas which gives the major pattern as if seen in perspective obliquely from aloft. The occupied area, coinciding with the area possible of irrigation by numerous small ditches leading directly from creeks, is delineated, so far as possible, by standard or at least

commonly used pictorial conventions.⁷ Care was taken to preserve the correct proportions of areas occupied and unoccupied. This was not always possible, however, because certain narrow creek bottoms, the usual limits of irrigation, are hidden from view by the towering benches of the older piedmont surface which form their abrupt limits.

The major pattern thus derived reveals the two principal occupancy areas. The most prominent and readily identifiable is that in the foreground east and south of the city of Buffalo (population 2000). Extending to the northeast from this body is a strip of irrigated land along Clear Creek, the master stream in this part of the extensive drainage basin of Powder River. Entering this stream just east of Buffalo are two affluents—French and Rock Creeks—readily identified by their narrow bordering strips of irrigated land. Three or four miles west of their junctions with Clear Creek is encountered the second main occupied area some three hundred feet above the alluvial lowland surrounding the city. The major pattern of this area is more complicated than that of the first, the complexities resulting largely from the transference of water across stream divides to supplement the normally small flow of short creeks whose bordering alluvial lands are nevertheless susceptible of irrigation. Water is transferred from French Creek, whose normal flow has been increased in like fashion by diversions from Clear Creek west of the diagrammed area, into the small tributaries of Rock Creek. In this manner the upper portions of those creeks are tied together into a nearly continuous network of irrigated lowlands surrounding or fringing the higher benches of the piedmont.

Another element in the major pattern is the system of roads. These center upon Buffalo, correctly indicating its local importance as a trade center and as a portal to Muddy Pass, one of the two main routes of travel across the Big Horns in Wyoming. All the travelled roads are shown but a branch railroad entering the region along Clear Creek has been eliminated from the diagram.

Elements of the Second Magnitude.—In the second order of magnitude are the elements contributing to the principal pattern of the occupied area. Cognizance was first taken of the basic fact that this is a region of occasional big stock ranches and numerous small stock farms forming a compactly occupied area. The areas of these holdings become progressively larger with increasing distance from Buffalo, the largest "outfits" (as the ranches are locally known) being on the periphery. One of these latter is now known as a "dude ranch" but it is located just beyond the western

⁷ See Lobeck, A. K., *Block Diagrams*, 173-174. New York, John Wiley and Sons, 1924.

limits of the diagrammed area. Two well-known ranches are named upon the diagram.

The boundaries of these various holdings are generally set by rectangular survey lines; within the holdings some field boundaries are straight and usually visible as fences, some are curving and ordinarily marked by irrigation ditches. The spacing of the pictorial symbols used for farmsteads indicates the varying sizes of the "home ranches"; hence the intervals increase with distance from the city. Characteristic field boundaries are suggested by dotted lines, but in the interests of preserving simplicity and of suggesting a real pattern, numerous actual lines have been eliminated.

Elements of the Third Magnitude.—In the third order of magnitude are the major land uses and these are consistent with the principal activity as already indicated. Over three-fourths of the irrigated land is used to raise hay for stock which normally finds part of its sustenance in the adjacent unirrigated steppe (principally in winter) and in the Big Horn mountains (mainly in summer). Ranking next in importance is irrigated pasture, followed by wheat, barley and oats, the latter two grains raised chiefly for supplementary stock feed. These proportions have been preserved in the conventional scheme but the diagram is not intended to be exact with respect to field uses.

Also designated are areas of seeped land, normally to be expected in a region in which irrigation has been carried on for a considerable time. Here water was first diverted in 1878, since which time stock raising, stabilized by this practice, has become so firmly entrenched that other land uses are distinctly secondary. The areas of seeped surface soils, being relatively permanent, are placed with exactness on the diagram.

Occasional shallow coal mines introduce a variant in the normal cultural scene. These penetrate the sub-bituminous veins of the De Smet Formation east and north of Buffalo. Many of these shallow veins have been burnt out in the past leaving scoriaceous clinker beds of dull red color and scantily clad with buffalo grass and sage. Dull red is thus the distinctive color of the dry lands east of Buffalo, made especially conspicuous in the light of the afternoon sun, and contrasting with the summer green of the irrigated lands and tree-bordered water courses and the dun color of the dominating higher bench lands to the west.

THE DIAGRAM AS A GENERALIZED TYPE MAP

Such are the dominant features of the Buffalo region as revealed by the diagram. Elaboration of the diagrammed features would be required to provide a complete and exact description of this part of the Big Horn Mountain piedmont. Necessary also would be several exceptions to general

rules as outlined above. On the other hand, such an elaboration would not notably increase the utility of the diagram as the generalized type map stated to be one of the objectives of its construction.

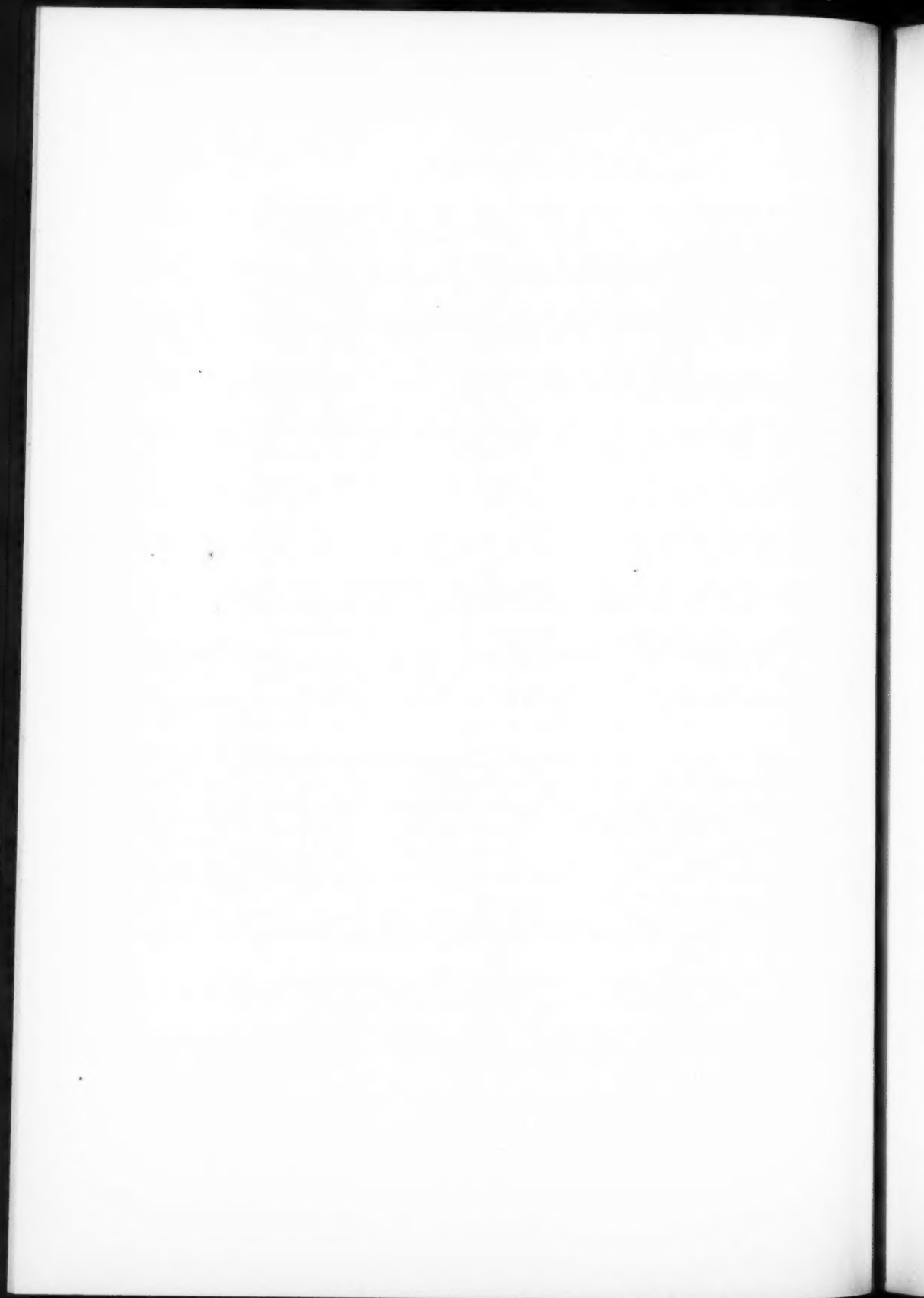
This diagram is representative at least, of those portions of the piedmont in the vicinities of rivers and creeks which rise well within the mountains. These streams include, south of Buffalo, the principal affluents of Powder River, notably its North Fork and Crazy Woman Creek, together with several tributaries entering Tongue River in the vicinity of Sheridan thirty miles north of Buffalo. Viewed as a whole, the Buffalo region is a portion of a long, narrow belt of transition from dry plains to humid mountains. During a reconnaissance comprehending the entire transition belt one is impressed with the continued repetition of the same landscape. This landscape has as its special quality the availability of water for irrigation, a resource brought into use within two years after the region definitely became a "cow country" with the quieting of the Sioux Indian uprisings along this portion of the Bozeman Trail in 1876. With the exception of the recent innovation of sugar beet culture in the vicinity of Sheridan, this activity has persisted with but little change since the 1890's. Small as is the irrigated area in proportion to the total area, the majority of the population of Johnson and Sheridan Counties has been and is concentrated in the transition belt.

It would seem quite reasonable to assume that the diagram is likewise typical of many another semi-arid piedmont of the Rocky Mountains.

A FIELD SKETCH OF PART OF THE SAME AREA

Figure 3 is a field sketch of the sort of landscape presented in the occupancy map and the regional diagram. It is inserted so that the reader may compare the impressions made upon him by the three different modes of geographic description.

*University of Minnesota,
March, 1935.*



The Impress of Effective Central Authority upon the Landscape

DERWENT WHITTLESEY

Political activities leave their impress upon the landscape, just as economic pursuits do. Many acts of government become apparent in the landscape only as phenomena of economic geography; others express themselves directly. Deep and widely ramified impress upon the landscape is stamped by the functioning of effective central authority.

By "central authority" is meant sovereignty over an area of marked diversity. To be "effective" the central government must exert more than nominal control over its area. Today "effective central authority" is a function of the national state.¹

EXPRESSIONS OF SECURITY

Security is one of the most valued products of effective central authority—the guarantee against molestation within the state and the assurance of resistance to invasion from without.

In the state which feels itself secure habitations are disseminated wherever this mode of settlement suits the economic life. In new countries (by "new" is meant those which have been settled in the current age of central authority) farmsteads are dispersed in most types of agricultural occupation. Even where the agricultural mode favors clustering, as in irrigated districts and on plantations and market gardens, the farmsteads commonly line up as stringtowns along roads, so that each may be centrally located in the midst of its farm land. This is in marked contrast to the farm villages in similar agricultural units of old countries. There the houses may cluster in tight knots. A good many are perched on defensible hills or protected by water, and are therefore inconveniently remote from the farm land. A comparison of the settlement patterns of Southern California and Southern Italy illustrates this distinction. In countries which were settled in eras of insecurity, defense points have now been to some degree abandoned in favor of more convenient sites. Crowded hills are deserted for open plain, as at Les Baux in Provence. Or hill villages expand downhill, but retain their ancient centers on the defense point; Spain supplies numerous examples of this shifting. In extreme cases the

¹ Unless capitalized, "state" is used throughout in its generic sense of "sovereign power."

crest is denuded of buildings and reclaimed for gardening (*e.g.*, Loudon, France). Sicilian villages which formerly hugged the coast and its protecting waters are pushing tentacles of farmsteads into the rolling, open uplands, now that the Mafia has been deprived of its threat to life and property. Where artificial defenses were formerly maintained, moated granges and villages free themselves for expansion by filling their encircling waters with their encircling walls. Where the agricultural system cogently favors scattered habitations, isolated farmsteads appear, concomitant with security.

Urban centers are precluded by their function from dispersing in the way farm villages may do, but they may and do spread out. Security not only permits them to occupy more space, but it stimulates both trade and manufacturing, their two chief reasons for existing. Flourishing economic life demands land for port facilities, rail and road terminals, and wide thoroughfares; space must be provided for retailing on a large scale and for wholesaling; professions and other services multiply; new largeness of ideas sets up new space requirements for residence and for recreation. All these call for acreage undreamed of in days of straitened insecurity.

Trade follows security, and trade has forced walled seaports to burst their bonds. All of La Rochelle but its port lies on land which was outside the walls in the 17th century; so also with San Juan, Puerto Rico. The easily defended *calanque* which has fixed the Rhône Valley seaport of Marseilles for at least 2800 years has been turned over to the fishing fleet, and a new commercial port filched from the open Mediterranean by jetties. London, Antwerp, Rotterdam, Hamburg, and many another estuary city has dug a new harbor in soft alluvium adjacent to but below the ancient constricted port. To obtain space for new business nearly every commercial city in continental Europe, and the larger ones in Japan, have converted their moated walls into boulevards. Paris and Vienna are the most famous examples, but Toulouse, Cologne, Seville, Milan, and hundreds of others, large and small, disclose the same history in their street pattern. Less spectacular, but more costly, is the widening and straightening of countless streets, and the substitution of modern buildings for medieval rookeries. Of all the square miles pierced only by ten- or fifteen-foot streets and still narrower culs-de-sac which made up fourteenth century Paris, only one small fragment survives today. The dead-end and zigzag alleys of Japanese cities are giving way to more regular plats of streets. Three centuries ago hardly a cathedral in Europe stood free from a parasitic congeries of habitations; today their plazas are open. The cluttered and congested urban landscape which expressed the day when political security lagged behind expanding business has all but disappeared. New

functions, particularly large-scale manufacturing and the manifold business of rail terminals, have grown up outside the "ring" boulevards which mark ancient fortifications.

The spacious residential suburb is likewise the product of an age of security as well as an age of fast transport. It has nothing but location in common with its precursor, the medieval faubourg, which was a slum huddled for protection against the walls of a city. Residences in most European and Asiatic cities retain the walled-in character of their predecessors. In the new countries of British origin, and even in Great Britain itself, dwelling houses are likely to face the street across open lawn, with no barrier except rarely a fence of wood or wire, or at most a low wall. The spacious habit of building each town house detached and not walled-off from its neighbors, seems to be the ultimate landscape expression of generations of security, beginning in Europe and transplanted to the colonies. At any rate it is practiced almost exclusively in English-speaking new countries, and most prevalently in the newer parts of them. But even there some time has generally elapsed between the abandonment of the stockade and the adoption of the detached house. The residential streets of little cities along the Atlantic seaboard of North America, such as Portsmouth (N. H.) and Charleston (S. C.), as well as the older sections of all the large seaboard centers, present solid ranks of abutting façades. West of the Appalachians only the most congested sections of the largest cities are built in solid blocks; in small cities and in residential sections of large ones the detached dwelling reigns, even where it is built with the intention of housing two or three families in "flats."

SPECIAL FEATURES OF BOUNDARIES

Expansiveness does not everywhere accompany security. Along international boundaries the landscape may be strewn with features intended by central authority to maintain security. At the least a custom-house and immigration post (often housed in the officer's home) stands sentinel at every major route crossing. On some European borders a gate, usually a heavy balanced pole, stands ready to be lowered at night and for any emergency. On minor roads a single military official is in sole charge. On main thoroughfares several men are stationed, often both civilian and military authorities. Even the undefended border between the United States and Canada is studded with official buildings where a few men are kept on duty. Along boundaries where acute tension is felt, either because of smuggling, antipathy between political systems which face each other across the line, or recent boundary displacements, the soldier guard may mount to a military encampment, although only at crucial passways. At the exit of the

Vall d'Arán in the Pyrenees, where the temptation to smuggle is powerful, the border is controlled by a small company of soldiers. On the Carso the new frontier between Italy and Yugoslavia near the strategic Peartree Pass is marked by a made-to-order garrison city, regiments of soldiers, airplane landing fields, ammunition dumps along the railroad, and freshly made military roads—all in a karst region almost bare of vegetation and apparently devoid of human inhabitants other than the garrison and its entourage. Even the St. Gotthard Pass on the border of peaceable Switzerland is heavily fortified.²

At railroad crossings there are, in addition to the usual officials, terminal facilities for trains which technically do not cross the border. In practice the terminal is generally in the town nearest the boundary, and not on the line. Whether the gauge differs or not, the terminal exists, because only a few of the trains go through, and in any event the locomotives and crews are changed. Many boundaries are closed to aircraft, except along specified lanes, which are as definite routes as roads or rails, although they are invisible.

Definition of boundary lines, *i.e.* replacement of boundary zones by boundary lines, follows upon the establishment of effective central authority. When central authority is weak, border districts, even if legally subordinate, are in practice at liberty to carry on their life pretty much as they please. They usually work out intimate economic reciprocity with neighboring political units, which themselves may be independent or nominally subordinate to some other inclusive state. Inhabitants of such harmoniously functioning border regions feel foreign to the people of their respective distant capitals, but not to their neighbors across the political boundary. When power is concentrated in a central locus, border zones are subordinated. Whenever the local interests clash with interests of the state as a whole, the border interests suffer. Central authority, to be effective, must proclaim fixed linear boundaries which can be defended against military aggression and economic penetration. Where political borders coincide with population deserts, such as oceans or large lakes, expanses of dunes without oases, perpetual ice, or dense forests, local life is little or not at all affected by fixing a linear boundary. In new countries, where a linear boundary has been drawn antecedent to settlement, the economic life conforms to it without strain, although tariffs often induce branch factories in border towns, and thus modify the landscape. Where manufacturing plants are built beyond the line to take advantage of tariffs, workers com-

² For details of border phenomena, especially those along the Franco-German boundary, see Hassinger, H.: "Der Staat als Landschaftsgestalter," *Zeitschrift für Geopolitik* 9 (1932), 117-22, 182-7.

mute from their established homes across the boundary, or if distance prevents this, they may move to new "line" towns on the frontier of their homeland. Rarely, a double town bestrides the line. In most regions the substitution of linear for zonal boundaries cuts off kinsmen from each other, parts business associates, and severs chorologic units. This is true even along mountains which are commonly thought of as barriers (*e.g.*, the Pyrenees), and populous plains such as Flanders, Lorraine, Posen, Silesia, have repeatedly seen towns lopped off from part of their upland, and have occasionally suffered the arbitrary dissection of cities.

Boundaries recently displaced are likely to mark zones of personal risk. On borders of the Polish Corridor and Upper Silesia transgression without the proper papers makes one liable to arrest and confinement, even though the culprit has not left his own property. Since boundaries are often arbitrarily drawn cross-country through farms and even through towns, this surveillance annoys the individual and so adds increments of personal hatred to the general enmity.

To guard against aggression many boundaries are lined with defenses, *e.g.*, the Franco-German border. Such defenses are linked by strategic roads and railroads, such as the Stelvio Pass road, the high-level bridge across the Kiel Canal, and certain railroads in pre-war Poland (many of which are now useless). The land thus used is withdrawn from other occupance. Towns along the boundary are semi-military, being differentiated from ordinary commercial towns by barracks, fortifications, and a general air of being supported by government rather than by business.

Boundary displacements may be followed by political acts which directly or indirectly modify the landscape. Slight changes, such as the substitution of one language for another on public buildings and street signs, are common. Even stores and offices may be required by law to display only the official language. Perhaps the extreme case at the moment is the Lower Vistula Valley. There an important railroad bridge across the river was first closed, and later moved to another site. A fishing hamlet among the dunes has been elevated into a modern port by the construction of costly harbor works, and linked to the interior of Poland by new stretches of railroad. Indirect pressure, such as government contracts, is exerted to deflect goods and people into this new all-Polish channel of ingress and egress. As a result Danzig, the ancient port city of the Vistula Valley, has to share the trade with its politically fostered rival. By treaty Danzig has accepted the smaller share—45 per cent to Gdynia's 55 per cent.³ Routes and other communication patterns are frequently altered

³ Other modifications of Germanic border regions since 1914 are discussed by Hassinger, *op. cit.*

after a boundary displacement; at first certain connections are closed or so restricted by inspections at the border that they fall into disuse; then new connecting links, suited to the new alignment of territory, are built. All this in the name of security.

EXPRESSIONS OF GOVERNMENTAL ACTIVITY

Central authority usually undertakes to act for the whole of its territory in specified matters. This tends to produce uniformity in cultural impress even where the natural landscape is diverse.

Public buildings of uniform function and form are commonplace examples. The post-offices in France, the army posts in all countries, the state capitols in the United States (these by imitation rather than prescription), are easily recognized types. In a very heterogeneous country, such as the United States, regionalism may be given recognition. Generally nowadays the federal government builds its post-offices in conformity to local tradition. In New England they are "colonial"; in California, Spanish; in the Middle West, either classical or modernistic.

In many new countries a uniform land survey, including routes, has been sketched upon the landscape antecedent to settlement. This is notably true of English-speaking North America, except for the colonial settlements and the Old South. It also applies, but much more locally, to parts of Latin America and other new countries, including settlements made centuries ago in eastern Germany, when it was "new." Perhaps the system of Roman roads, still conspicuous features of the route pattern in Romanized Europe, may be cited as an additional and still earlier example of a pattern of communication ordained by central authority.

In the Roman permanent "camps" of Western Europe, and in towns laid out by Germans as they pushed eastward after the tenth century, rectilinear street patterns within circular or elliptical walls are common, although blocks are likely to be unequal and streets not quite straight. Modern national governments began to sponsor fiat towns early in the seventeenth century. The gridiron pattern of streets was seized upon as convenient, since the new towns were generally laid out on plains and defense was not necessary.⁴ Richelieu in western France, laid out by an officer of the Church, and Mannheim on the Rhine, laid out by a military officer of the state, are samples. The grid proved to be an equally handy pattern for mushroom towns in new countries. Nearly every municipality of the Pampa, except Buenos Aires, is an example. Philadelphia is an

⁴ As compared to a jig-saw pattern shot through with a few radial lines, the gridiron city is difficult to defend. Ambush, barricades, and central command are handicapped.

early case (1682) in North America. The Dutch followed the scheme in Batavia. In these cases the orientation is rarely due north-south and east-west. Compass orientation of city streets fits naturally into the coarser grid of the rectilinear survey, adopted in many new countries. Melbourne is an example from the antipodes. Chicago is the outstanding case of the very large city oriented north-south and east-west, and monotonously and regularly extended. The almost featureless lacustrine plain on which it lies has neither compelled nor encouraged deviation from the ideal plan. The offsets which accommodate the straight-line survey to the spherical earth appear as jogs in the street pattern. Numerous new suburbs of old cities throughout the world have been similarly platted. Where no rectilinear survey exists, grids may have any conceivable orientation, *e.g.*, along streams, country roads, or railroads, or hinged to a stretch of fortification-turned-boulevard.

Most gridiron street plans have not been directly imposed by governments. The appeal of convenience, however, has been irresistible in an age when new cities and new suburbs of old cities have been multiplying on open plains, thanks to increased trade and manufacturing made possible by powerful government.

Governments often stimulate migration into newly acquired areas by offering landholdings larger than those current in regions from which settlers are drawn. This distinction tends to disappear in time unless it is reinforced by the natural environment. In the Pampa large holdings, originally stock ranches, persist because they carry social prestige, but much of the land is now under the plow, being tilled by tenants on short-term leases. Eastern Germany, wrested from Slavs, was blocked out by the invaders from the west in large, uninterrupted units, strikingly in contrast to the crazyquilt of both holdings and fields in parent Germany. These very large units persist today chiefly in rugged, marshy, sterile districts where small farmers can not make a living and horse raising affords a genteel occupation.

As the United States approaches demographic maturity, the average size of landholdings is undergoing progressive change toward harmony with the environment. In the Corn Belt the typical patent from the government granted 160 acres, a figure not far from the unit which in that region can most effectively be worked by a single farm family. Farther west, in the semi-arid and desert country, this unit early proved too small, and homestead allotments double and later quadruple this size came to be permitted by law. Where grazing or dry-farming dominates, even 640 acres is too small a unit, and holdings are being merged to form adequate ranches. In the irrigable areas of "Mediterranean" California and "Egyp-

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tian" Arizona, on the contrary, the original large holdings, many of them stock ranches dating from Spanish times, are being morselled into twenty-, ten-, and even five-acre lots.

The existence of effective central authority implies the power to collect taxes and distribute funds throughout the whole territory of the state. Notable modifications of the landscape have resulted from the habit governments have of distributing to backward and to pioneer sections money collected from prosperous districts. This is, in other terms, a transfer from regions favored by the natural environment to regions laboring under temporary or permanent environmental handicaps. The Tennessee Valley Project of the moment is a spectacular example, but the principle has long been in operation in the United States, thanks to loose construction of the Constitution. Much of the irrigation of land in western States has been paid for from federal funds; the federal government provides aid in building roads, especially in sparsely populated regions; and many of the railroads in North America (and in every other continent) have been similarly aided, wherever they have been trajected through difficult or unpeopled territory. In North America and Australia, at least, the States and the Provinces have carried this redistribution of funds further. The southern half of Michigan, Wisconsin, Minnesota, and Ontario each supports schools and roads in the northern quarters; in like fashion the eastern part of each Great Plains State contributes to the maintenance of its western part, and humid Australia to the arid ends of the several States. Lowlands in mountainous middle latitude countries spend a part of their taxes for objects which make habitation of the highlands possible. Forests and recreational preserves in handicapped regions are likely to be maintained by central government. From this view-point the study of pioneer areas as undertaken recently by the American Geographical Society resolves itself into these problems: first, how much government aid is needed; and second, how much it is socially wise to disburse in any given area.

A number of regions, prosperous enough to support themselves in local affairs, can benefit greatly if given aid from the central government on specific problems which transcend a single region. Flood prevention in the Mississippi Basin is too comprehensive a task to be dealt with effectively by any existing political unit smaller than the United States. Reclamation of the Zuyder Zee by the Netherlands, reforestation in Alpine Europe and elsewhere, the construction of *autostrade* by the Italian state and similar national road systems wherever automobiles are important, the Canadian policy of supporting intersectional railroads, hydro-electric installations in Ireland and Russia—all these are examples of comprehensive undertakings which only central authority can handle.

Public funds available for regional redistribution may be misdirected. Some unwise expenditure results from necessary experimentation, since governments have had relatively little experience in enterprises of this nature. Political favor and log-rolling cause other and lamentable leaks. The federal appropriation for "rivers and harbors" in the United States has been notorious for a century. Every country no doubt has counterparts of our pork barrel. An abuse hard to eliminate arises naturally, as useful institutions become antedated or cease to satisfy the needs of the community. Vested interest, often supported by law, prolongs customary expenditure for indefinite periods. The continuance of army posts in the United States Indian Country, the support of the established church in England, are cases in point.

Government lays hands in a special way upon its capitals. The focusing of roads, railroads, and canals upon the seat of government is partly the result of economic evolution, but it is often encouraged by political aid. Berlin, for instance, is not the center of Germany to the degree indicated by its hub of communication lines. The location of some capitals has been shifted in harmony with migrating political power. Nearly every one of the original United States moved its capital from the seaboard to the interior, as population increased in the back country. The reverse process occurs when overseas powers impose their rule upon settled communities. The seat of administration may then be brought to the coast, as from Cuzco to Lima, from Kandy to Colombo, and from Delhi to Calcutta.

Once fixed, capitals become the pets of government. On them public money is frequently lavished beyond present needs, even beyond the natural desire of the people to dress up their capital city. Delhi, Peiping, Berlin, Rome (both ancient and modern), are notable examples of generous expenditure. All these cities are splendid to look at, and each looks very different from the ordinary commercial city. Minor capitals have been garnished in proportion to their funds. Every German quondam state has an imitation Versailles, and the forty-eight democratic United States of America have spent staggering sums to house their governments. Washington and Canberra, as purely political fiat towns, are the clearest beneficiaries of political favor, but even London, primarily a world port and the leading manufacturing city of Britain, is impressively the capital of a nation and an empire. The spaciousness of modern capitals—"Washington, city of magnificent distances," Paris with its broad boulevards, Rome, roomy enough to accommodate both the modern capital and its exhumed predecessor of antiquity, are made possible by the security which central authority affords. Some governments which have spent overmuch on dressing up their capital cities have been overthrown not long after. Athens of

Pericles and Versailles of the later Bourbons by their very splendor contributed to the undoing of their sponsors.

Outside the capital city the hand of government puts its stamp on many places. Universities may form the nuclei of small cities. Prisons strikingly modify the landscape and in places, as at Princetown on Dartmoor, dominate it. Experimental farms may occupy large acreage. All these are exceptional. Most government agencies are housed in buildings more or less lost in ordinary towns and cities—district courts and police registration bureaus, central banks, port headquarters, and the like. Yet they are likely to bear clear evidence of their official character. If built of costly materials in a massive or a pretentious style, as is commonly the case, they stand out among their neighbors. The site too is likely to enhance their distinction. It may be a conspicuous hill, a plaza, or a park, such as only government can afford. On the other hand it may be an out-of-the-way spot or an obscure block on a mean street which people would never search out but for government compulsion. A government building erected in a poor neighborhood improves surrounding values. Conversely, if the site happens to be in a retail shopping section, the government building, lacking show windows and shops, no matter how fine a piece of architecture, serves as a damper to trade, and surrounding land values are thereby lessened.

LAWS RESULTING IN LANDSCAPE MODIFICATIONS

Tariffs imposed by central authority set their mark on widely separated regions. The incidence of tariffs is determined largely by economic geography. Those which fence out foreign manufactured goods lead to the creation of new manufactural districts, as in Montreal, Toronto, Hamilton, and Windsor, in Canada. Budapest and Ljubljana are creating factory districts to supply peoples formerly served by Vienna. Tariffs or subsidies applying to agricultural produce favor agricultural systems different from those which would exist with free trade. Examples: the large acreage of wheat in France, a cool, moist land; the intensive spots of tobacco and sugar beets in nearly every country of Western Europe; sugar-cane as the dominant crop in Hawaii, Puerto Rico, the Philippines, and a crop of moderate importance in Louisiana.

Embargoes of other sorts alter the location of items in the landscape. The refusal of the State of Maine to permit the exportation of its water power leads to the building of a large pulp-mill on the Lower Penobscot to use Kennebec power and imported pulpwood. Power developed in New Hampshire on the Upper Connecticut in the same year is shipped to populous Boston and vicinity for miscellaneous manufacturing and lighting. Dissatisfaction with Mexican participation in an irrigation canal which

crosses the international boundary in the Imperial Valley spurs on the construction of an all-American canal on less advantageous terrain.

Laws affect both the tempo and the direction of settlement in all new countries, although in the process the law itself is much modified, or where it conflicts too stridently with its new-found environment, abrogated.

The early European settlements in the New World, made in the fifteenth century, were launched under franchise from European governments; in many cases the present political subdivisions are bounded by the terms of those franchises. Sea-to-sea grants in British North America account for the east-west boundaries of several States on the Atlantic seaboard and in the Middle West, boundaries which run counter to the grain of the country. The Papal Line of Demarcation of 1493-4 accounts for Portuguese Brazil in Spanish America and for four centuries of Spanish rule in the Philippines.

As settlement progressed inland from footholds on harbors, it was protected or hampered or deflected by the aegis of the law. At the outset the seigneurial system dominant throughout Europe was transplanted to the new continents. It suited the plantation system of agriculture and has never been much modified where that mode of land use still prevails. For centuries it suited the Pampa, a remote grassland where livestock ranching paid better than any other agricultural system. With increasing demand for grain, all the more humid Pampa has recently become potential wheat or mixed farming country. Thus far the social prestige of immense estates, fortified by the law, has retarded their subdivision, although more and more land is being tilled under a wasteful system of tenantry. In contrast to the Pampa stand Canada and the United States. In New England particularly, the seigneurial system never took root; elsewhere, except in the plantation South, it was abandoned because the small farm better fitted the environmental conditions. As settlement swept inland from the humid seaboard into the humid Middle West, homestead laws fixed the size of individual's claims to unappropriated public land at a figure which had proved satisfactory in the parent States. In sub-humid regions, where tillage has to be extensive, and still more in regions so dry that only grazing can prosper without irrigation, application of these laws predestined homesteaders to hopelessly inadequate holdings. The common practice of allotting alternate sections of the land to railroad companies as an inducement to extend the rails, further complicated the pattern of land holdings. Successive laws increased the acreage allowed, but they came too late to benefit most of the stock raising country. It has been found difficult, often impossible, to piece together from abandoned claims and the rigid checkerboard of railroad holdings, enough land with the proper balance between winter

and summer pasture and with suitably spaced waterholes, to make a successful stock ranch. As a result some land is overgrazed while other land is not used to its capacity, or is occupied without legal right.

The general progression of settlement in new countries of British origin has been from humid to arid. The English Common Law did not require much modification to serve for the humid parts of the United States and the British Dominions, but when it began to be applied indiscriminately to dry regions some sections of the code were found to run so sharply counter to local needs that they had to be abrogated. To cite a notable example: riparian rights if adhered to would have prevented the installation of irrigation works, without serving any useful purpose in regions devoid of navigable streams. Conversely, laws had to be drafted to safeguard the rights of irrigation farming, since the Common Law, a native of the humid English climate, incorporated no such rules. In the San Joaquin Valley of California litigation between landholders who wished to maintain riparian rights and those who desired to divert water for irrigation, retarded the evolution of "Mediterranean" agriculture for decades. Even today not all the irrigable land is under ditch, and in each irrigated district the crops grown are dominantly those which promised profit at the time when legal controversies happened to be settled.

Laws affecting the use of land and natural resources are not confined to new countries. Every considerable social revolution produces its crop of laws affecting land holdings. Generally such laws are calculated to break up or to prevent the rise of large estates, to restrict holdings to small acreage, and to limit the agricultural occupance to those modes in which small holdings pay. In Rumania, Russia, Ireland, and other parts of Europe where estates have been subdivided during and since the World War, subsistence farming has generally replaced commercial farming, crude tools have replaced machinery, fields have been reduced in size, the percentages of crops grown and stock reared have changed, and in places soil fertility has decreased. In general small holdings in Europe favor stock raising at the expense of grain production, since the small proprietor can pay careful attention to his animals, whereas he may not be able to afford the machinery needed for economical grain growing on a commercial scale.

In the Philippines plantations large enough to attract foreign capital may not be owned by outsiders. In Java laws imposed by the Dutch have the effect of maintaining a fixed ratio in the acreage of the major crops. This restricts unbridled planting of commercial crops and reserves adequate acreage for the food crops on which the natives subsist. In Cuba and Brazil laws forbid or limit new plantations of certain cash crops produced in excess of the market demand.

GOVERNMENT AND REGIONAL GEOGRAPHY

Examples of cultural impress of effective central authority upon the landscape can be multiplied indefinitely. The cases cited suffice, however, to point to a group of geographic phenomena often overlooked. Each deserves more detailed study, particularly in its regional setting. Phenomena engendered by political forces should have a recognized place as elements in the geographic structure of every region.

*Harvard University,
October, 1934.*



A Classification of the Agricultural Regions of Europe and North America on a Uniform Statistical Basis

RICHARD HARTSHORNE AND SAMUEL N. DICKEN

Geographers and agricultural economists have become increasingly interested in recent years in studying the associations of crops and livestock in different types of agriculture, in contrast to the separate consideration of individual crops or products. Detailed studies of different "types of farms" have been made by various State Agricultural Colleges and Experiment Stations, alone or in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture. The United States Bureau of the Census has published a detailed study of "Types of Farming in the United States," based on the 1930 census, in which more than 800 districts are mapped and classified.¹ For broader regional classification the great contribution has been the series in *Economic Geography* on Agricultural Regions of Europe, North America, South America, Australia, and Asia.²

Throughout most of the United States and Canada agriculture is essentially European in character, in the use of the land for crops and pasture, in the use of the crops for man and for domestic animals, and even to a considerable degree in the methods of cultivation. The rural landscapes are therefore, excepting for the distribution of farmhouses and farm villages, strikingly similar, when looked at, say, from the point of view of Oriental or plantation regions. The South, with its cotton fields, is of course very different in many ways and will therefore be largely omitted from the discussion. But in the other farm regions of this country and Canada the crops and farm systems are direct importations from Europe by the European settlers, with two major exceptions of corn and potatoes.

¹ U. S. Bureau of the Census, (Foster F. Elliott), "Types of Farming in the United States," 1933.

² Published more or less continuously in *Economic Geography* since Oct. 1925, by the following authors: Jonasson, Olof, "Agricultural Regions of Europe," Oct. 1925, Jan. 1926; Baker, O. E., North America, 12 installments, Oct. 1926-1934; Jones, Clarence F., South America, 7 installments, Jan. 1928-Jan. 1930; Taylor, Griffith, Australia, 2 installments, Apr.-July 1930; Van Valkenburg, Samuel, Asia, various installments, July 1931-ff.

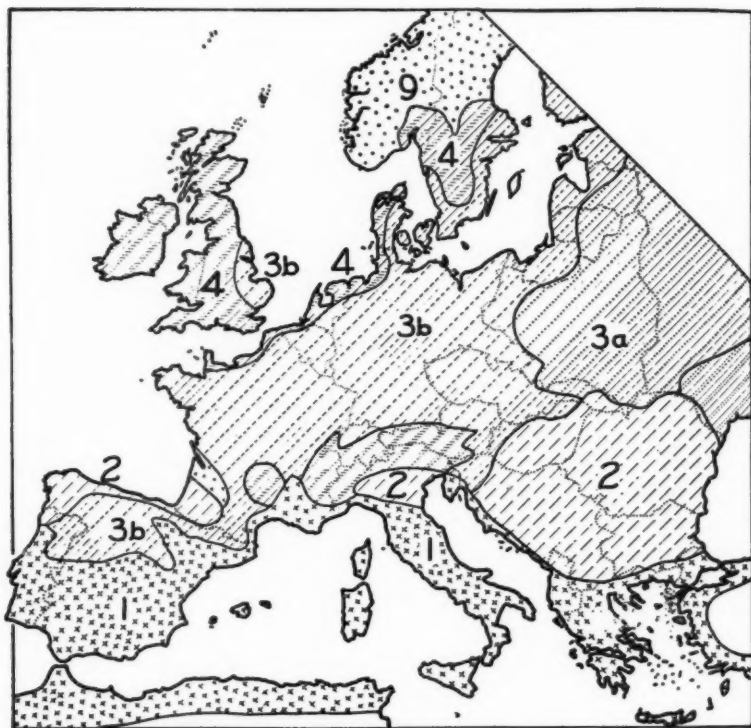


FIG. 1—Agricultural types in Europe. (Note Type 5 in the Ukraine).

KEY FOR FIGS. 1-2: 1—Mediterranean; 2—Corn-wheat-livestock; 3—Small grains-livestock; 4—Hay-pasture-livestock; 5—Extensive commercial grain; 6—Truck farms and commercial orchards; 7—Commercial grazing; solid black dots represent irrigation districts; 8—"Quasi-plantation" systems; 9—Forests and unused.

These exceptions, however, have long since been incorporated in the agriculture of Europe itself as major elements wherever they can be produced. Consequently it seems logical to seek for a classification of farm types that will be applicable to both continents, in order to delimit the major agricultural regions on both sides of the Atlantic.

THE CLASSIFICATION SCHEME

Five types of agriculture are distinguished: one emphasizes tree and vine crops, with little livestock; two exemplify diversification, distinguished from each other by the importance of corn as a major field crop; one is

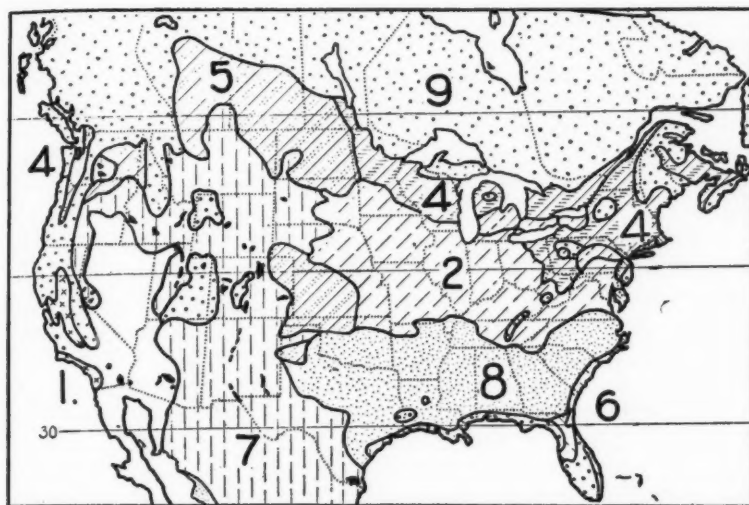


FIG. 2—Agricultural types in the United States and Canada. (Note Type 3 from central Michigan to western New York and in two districts in Pennsylvania).

highly specialized in bread grain production on an extensive scale; in another, field crops are less important than hay and pasture, which are used for the commercial production of dairy and meat products (Figs. 1, 2, and 10).

In order to put the classification on a scientific, *i.e.*, measurement, basis, the regions are delimited statistically, the first attempt, we believe, to do this for both these areas.³ The limiting criteria were selected from a large number of different kinds of isopleths, based chiefly on crop acreage, after the manner suggested by Wellington D. Jones.⁴ For any particular limit,

³ Jones and Whittlesey have used statistics to select type areas, but they have bounded their types statistically only in part. Jones, Wellington D.: *Syllabus for Geography 102*, The University of Chicago. University of Chicago Bookstore, 1932; Whittlesey, Derwent: *Types of Agricultural Occupance*. Harvard University, 1935. (Both of these are in mimeographed form).

⁴ Jones, Wellington D.: "Ratios and Isopleth Maps in Regional Investigation of Agricultural Land Occupance." *Annals Assoc. Amer. Geog.* Dec. 1930, pp. 177-95. Isopleths were drawn, chiefly for parts of the United States, Germany, France, Italy, and Spain, of the ratios of each major crop, and of various groups of crops, to total cropland, in some cases to the total used land (crop and pasture), of crop or used land to all land, and of cattle and of total animal units to crop or used land.

that isopleth was selected which seemed to represent most closely the change from one definite type to another. In a number of cases that one was selected which conformed most closely to the boundaries based on value of products (as in Elliott's Types of Farming map, and some of O. E. Baker's limits in the United States); the ratio based on acreage was regarded as more significant geographically than one based on value, not only because it is an actual area measurement but also because it fluctuates much less widely from year to year. In some cases it was found that the isopleths of a particular ratio are closest together near the limiting line, indicating a steep "slope," at times even an "escarpment," to the next type of land use (as along the limit of the Cotton Belt in the United States, or the Mediterranean regions in Europe) so that it would actually have made but a minor difference if any one of two or three lines had been chosen.

Each type of agriculture is illustrated by graphs showing the crop and livestock associations in one or two type areas. The crop bar, in each of these graphs, is divided according to the percentage of total cropland in each crop. For type areas in the United States, the actual area in each crop, and the actual area in pasture, and in woodland not used for pasture, is indicated by the width of the bars; the width of the three bars together then represents the (statistical) average farm of that county. For the European areas the actual acreage is not shown, the crop bars being all of the same width, regardless of size of farm. In the livestock bars the figures represent the actual number of each kind of animal, but the length of each part and of the total bar is proportional to the number of "animal units" per 100 acres of cropland. ("Animal units" are figured according to the U. S. Department of Agriculture ratio: 1 animal unit is represented by 1 horse, ass, cow, (or buffalo); 5 swine; or 7 sheep or goats. Poultry, 100 to 1 unit, are omitted, as the figures are in many cases not available).

I. MEDITERRANEAN AGRICULTURE (FIG. 3)

In the area around the Mediterranean Sea having the type of climate commonly called by that name, is found one of the most distinctive and hence universally recognized types of agriculture. It is distinguished from other Occidental types in the special importance of tree and vine crops, and in the minor importance of animal feed crops in comparison with human food crops. These are all grown chiefly for subsistence and local trade. Wheat is the all-important field crop, excepting on the margins of the steppe, where barley supplants it, and in highly commercialized districts which import flour. Olives for oil, grapes for wine, and, in some areas, chestnuts for food, are of great importance for local consumption as well as trade. Commercial crops include citrus fruits of all kinds, raisins,

figs, dates, and a great variety of early vegetable products. Cultivation is most intensive, field crops being grown between the rows of the orchards or vineyards, and tree crops grown along the borders of the fields and roads. Most of the fruit and vegetable production, other than olives and vines, requires irrigation, but the field crops are grown commonly without it, excepting corn.

In many areas goats are the principal source of milk, which is consumed locally or made into cheese; butter and lard are supplanted by olive oil. Meat production is low; swine especially are of minor importance (Fig. 3a—Sicily).

In many large interior areas of drier or rougher land an upland sub-type might be recognized in which wheat, barley, and perhaps chick-peas are the only important crops (excepting in irrigated valleys). Large parts of these areas are used only for grazing, in semi-nomadic fashion, of cattle and particularly sheep, the latter primarily for wool.

Variations of this type of agriculture are found in most other areas having the Mediterranean climate. In southern California the agriculture

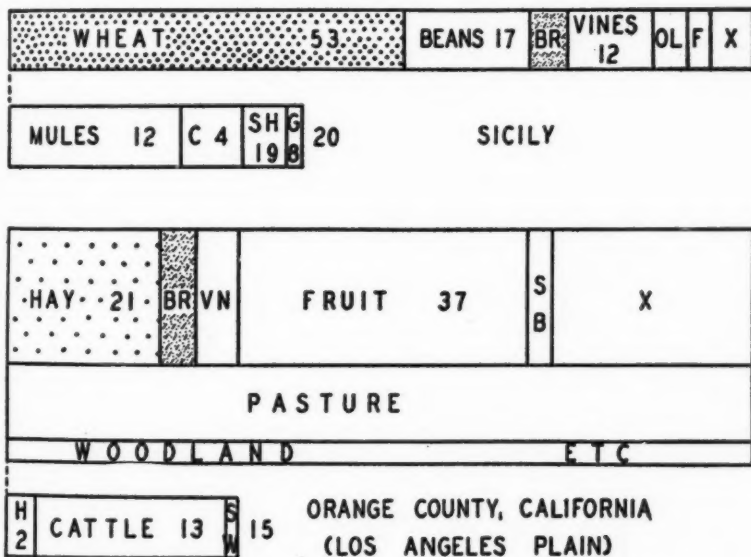


FIG. 3—Type areas of Mediterranean Agriculture. BR—barley; F—fruit orchards; OL—olive orchards; SB—sugar beets; VN—vineyards; X—other crops and fallow; C—cattle; G—goats; H—horses and mules; SH—sheep; SW—swine. Total livestock units are expressed in figures at the right end of the bar.

is highly commercialized, fruit and vegetable production dominating. The influence of the North European origin of most of the inhabitants is seen in the absence of olive orchards and vineyards, excepting in concentrated commercial districts, and in the important dairy districts around the large cities (Fig. 3b—Orange Co., Calif.).

The limit of this region is drawn along the following isopleth: olive, citrus fruit, and nut orchards plus vineyards⁵ equal 15 per cent of the total cropland other than hay. Commonly the proportion of these typically Mediterranean non-field crops is much higher—25 to 60 per cent in the areas in Spain, France, and Italy.

GRAIN AND LIVESTOCK FARMING

The other main types of Occidental Agriculture have much in common and might conceivably be considered as a single type. The differences between them, however, are especially important to commerce since these types include the principal areas of the world devoted to commercial agriculture. With few exceptions the regions having these types of farming have been developed by peoples of northern European descent, whose customs of food and of farming are inherited largely from the subsistence farming system developed in Europe north of the Alps before the Industrial Revolution.

That system had three main features: (1) the production of wheat or rye, or both, for bread; (2) the production of butter, cheese, and milk, almost exclusively from cows; and (3) the production of meat from cattle, hogs, and sheep. In addition, poultry were important for their eggs, to a lesser extent for meat; the wool of the sheep was essential for clothing; flax, from which linen was produced, was a minor crop; and various vegetables were of some importance, though much less so than in Oriental agriculture. The cutting of firewood either from farmers' woodlots or from the forests that surround most of the small farming districts was important in the long winters, both for the farmers' supply and for local trade. In comparison with almost all other agricultural types in the world the outstanding characteristic of this general system is the importance of livestock on the farm, the associated raising of field crops and hay to feed them, and the importance of farm pastures, used generally only in the warmer months.

⁵ Vineyards are found, of course, outside the Mediterranean areas but only in special locations. As a general regional feature of major importance they are characteristic of Mediterranean agriculture. The only region with humid summers which is included in this type lies in the vicinity of Bordeaux (Fig. 1).

Because these areas include the two major industrial regions of the world with their enormous demand for food products, particularly (because of the European food habits) for bread, meat and dairy products, commercialization of the farm regions has led to a marked differentiation, especially in the products sold. Some regions specialize in production of bread grains, others of dairy products or of meat, but many regions remain, even in their commercial production, "diversified," producing some of all three major elements. Further, in nearly all the regions considered, these three main elements remain characteristic of the production for home use.

II. CORN, WHEAT, AND LIVESTOCK FARMS (FIG. 4)

Throughout these northern regions wherever the length and warmth of the growing season permit, corn is either the most important crop or

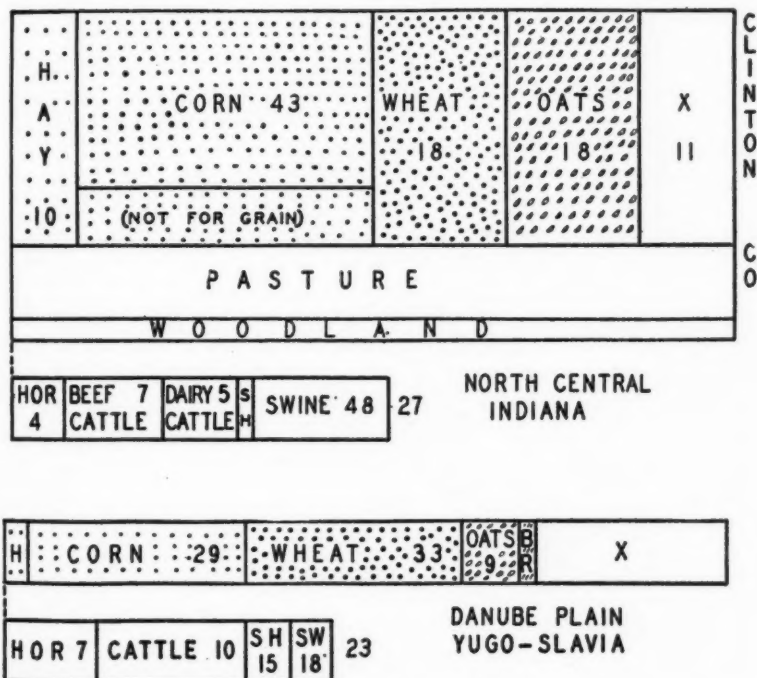


FIG. 4—Type areas of Corn, wheat, and livestock farming. (The Danube area is the former Voivodina province of Hungary). H (crop bar)—hay; "Beef cattle" on this, and other graphs, includes all other than milch cows.

is second only to wheat. Generally speaking, feeding crops, including oats, barley, and hay as well as corn, are more important than food crops, and livestock usually number well over 20 units per 100 acres of cropland. Animals are generally raised primarily for meat purposes, hogs are especially important, dairy cattle are of less importance, though there are exceptions such as the Po Plain in Italy, districts close to great city markets, such as Chicago and Philadelphia, and rougher regions such as the driftless area of southwestern Wisconsin and adjacent States. Wheat is important for local consumption and also as a commercial crop in most areas, occupying as much as one-fourth of the cropland. It is only in the Southern Appalachians and in the western (*smaller*) part of our so-called Corn Belt that wheat is eliminated.⁶ The boundaries of this type were determined by the condition that corn occupies at least 20 per cent of all the cropland, corn and wheat together at least 30 per cent; and cotton occupies less than half the area in corn, tobacco less than 20 per cent of the cropland.

In the areas of commercial farming of this type the number of significant crops is small—three or four, including hay—but there may be a very considerable list of commercial products. Though the meat animals, steers and hogs, are of major importance, meat farms produce at least a small surplus of cream or butterfat from their dairy cows, and eggs and poultry are important minor cash products. Furthermore, in addition to the surplus wheat sold, many farms produce a surplus of the feed crops—corn, oats, and hay—which are not only sold locally but may be exported. (Examples: Clinton Co., Ind., Fig. 3; Voivodina, in Danube Plain, Yugo-Slavia, Fig. 4).

The relative importance of these different commercial products varies greatly not only between different areas of this type but between different farms within the same district, and even on the same farms from year to year (at least within the United States). The *crop systems* however are much more constant in any region, both from farm to farm and from year to year.

In certain areas of the United States there is a high degree of specialization on certain of these groups of commercial products. Thus in eastern Illinois commercial grain farming predominates (but intensive in contrast

⁶ But wheat is not eliminated throughout the Corn Belt, as is implied by the distinction between a "Corn Belt" and the so-called "corn and winter wheat belt." Throughout the eastern half of the Corn Belt, winter wheat is more important than it is in some parts of the "corn and winter wheat belt" (see Clinton Co., Ind., Fig. 4a); in fact large portions of the latter belt have no wheat at all. Since the only elements which the different parts of that belt have in common are also found in the region known as the Corn Belt, no logical reason is seen for separating them.

to Type 5 below), livestock are few—under 15 per 100 acres cropland, so that most of the grain is sold out of the region. Since the requirements for hay and pasture are so small, the proportion of the fertile plain used intensively for grain crops is the highest in the United States—74 per cent of the total area.

In the level plain of Iowa, on the other hand, is found the greatest concentration of beef and hog production in the country, and wheat is largely eliminated. "Feeder" farms, importing lean cattle from the grazing areas of the west for fattening, are characteristic.

In the highly dissected unglaciated area in northeastern Iowa and bordering States, and the adjacent rough moraine, the great amount of land suitable only for hay and pasture has led to specialization in butter and cheese products, with veal and pork as by-products. This area is included within this type, rather than the hay-pasture type, because corn is still the major crop, though wheat is eliminated. The same is true of the rich plain extending east of this area to Chicago and Milwaukee, which specializes in milk products for those cities. Since the dairy cattle must have more bulk food, more of the level land is in use for hay and pasture—*less intensive uses*—than in similar areas farther from cities.⁷

In several areas included in this type the agriculture is somewhat mixed with characteristic elements of one of the other types. One such mixed type of farming is found in the tobacco-growing area of the Blue Grass region in Kentucky, together with parts of western Kentucky and Tennessee. This is essentially transitional between the food and livestock farming of the North and the semi-plantation production of industrial crops in the South. In terms of land use the farms are primarily diversified corn, wheat, and livestock farms with unusual emphasis on rich pasture used for beef and dairy cattle, as well as the more famous horses; in terms of cash income, labor, and the characteristic barns constructed for drying the product, they are more largely tobacco farms.⁸

Similarly the Po Plain of Italy, on the basis of its corn, dairy cattle, and swine, unquestionably a region of this type,⁹ has also certain Mediter-

⁷ In southeastern Pennsylvania, similarly located with reference to city markets, there remains more diversification; wheat is an important crop and in one part, Lancaster County, tobacco and beef fattening are important.

⁸ The tobacco area of North Carolina-Virginia is much more definitely concentrated on tobacco production, and even cotton, with but little development of livestock production (relying more largely on commercial fertilizers for maintenance of soil fertility), and is consequently included in the quasi-plantation belt of the South.

⁹ The four provinces which make up the Po Plain, together with foothills of the Alps and Apennines, had the following percentage distribution of the cropland:

anean characteristics. Thus, in addition to the small area of specialized vineyards, a large part of the cropland has grape vines in the fields of other crops. The important chestnut production and particularly the small district of minor rice production are likewise exotic elements for this type. (The narrow strip along the foot of the Alps generally recognized as definitely Mediterranean could not be distinguished in the provincial statistics).

Finally the lower Danube Plain in Rumania is often included in Extensive Commercial Grain Farming (Type 5) on the basis of its wheat and corn exports. But these are much less in amount than the grain consumed locally, especially since the break-up of the large estates after the War, and livestock are also important on the small peasant farms. Special characteristics of this region (together with the adjacent subsistence highland areas from which its farmers emigrated in the last century) are the dependence on corn as the major food rather than wheat, even though both are grown, and the use of sheep for dairy animals.

The subsistence form of this corn, wheat, and livestock farming is confined to inaccessible hill and mountain areas, in the Southern Appalachians and the Ozarks in the United States, in the Carpathian and Balkan highlands in southeastern Europe.¹⁰ With primitive and wasteful methods of cultivation on land naturally low in fertility, the population, which is nevertheless *denser* in proportion to the cleared land than in the neighboring plains, lives on a very low economic level. Corn, grown for human consumption, is not only the major crop but in some districts almost the sole crop. Periodically abandoned fields and partially cleared forests as well as the cleared slopes are used for pasture for cattle, sheep, and (in Europe) goats, while hogs roam the forests for mast. These lean and rangy hogs furnish something of a commercial product, being driven out of the hills to be sold to feeders or directly to packers, but inaccessibility, and in Europe tariff barriers, greatly restrict this movement (Fig. 6).

III. SMALL-GRAINS AND LIVESTOCK FARMING (FIG. 5)

The characteristic crop system of northern Europe consists of wheat or rye or both, raised for bread; potatoes for food, or for both food and

wheat 42, corn 23, legumes 8, rye 2, potatoes 2, sugar beets 3, hay 3, vineyards (not in fields) 5, others 10; livestock per hundred acres cropland: horses and mules 8, cattle 57, goats 2, sheep 8, swine 20, total animal units 70.

¹⁰ The subsistence areas in the United States are mapped in U. S. Census, "Types of Farming," *op. cit.*, and also in *Census of Agriculture 1930*, Vol. III, p. 10. The subsistence area in Jugo-Slavia is described as south of "a line drawn from Zajecar, on the Bulgarian frontier, to the Prina River, thence north to the River Sava, and west to Fiume," U. S. Dept. Agric. *Tech. Bull. No. 126*, p. 141-2. This line is shown on Figure 6.

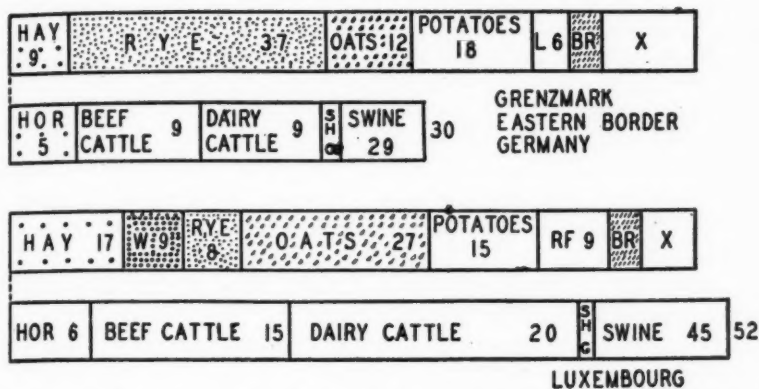


FIG. 5—Type areas of Small-grains and livestock farming. L—legumes; RF—root forage; SH G—sheep and goats together.

feed; and oats, barley and hay raised to feed livestock producing both dairy products and meat. Roughly speaking, in Europe north of the Alps and Carpathians, and in eastern Canada and the northernmost states of the United States the growing season is either too short, or too cloudy and cool, for the maturing of corn in most years. Where the season is short but warm enough, faster growing varieties of corn are planted, and though the greater portion of the crop may not mature, it can be harvested green for silage, and thus used for winter feed for dairy cattle. Even where this is possible corn is much less important than in the areas farther south. Along the margin of the corn-raising area in north central United States the corn acreage is nearly one-fifth of the total cropland, but it decreases rapidly toward the north, being less than one-tenth in northern Wisconsin and Michigan. In northwestern Europe corn is not even grown for silage, though large amounts of imported corn are bought for feed.

The livestock production of this type consequently depends on the lesser feed grains, oats and barley, and particularly on hay and pasture, together with silage corn in parts of North America, and various root crops and potatoes in northern Europe. Since this provides relatively better feed for dairy cows than for beef cattle and hogs, the tendency in the commercialized farms of these types is to concentrate on dairy cattle rather than meat animals, so far as market conditions permit.

The conditions which prevent the use of corn as a major crop have much less effect on the growth of the bread-grains, wheat and particularly rye. Rye reaches its greatest importance in this type, constituting the chief crop over wide areas of central and eastern Europe. In Scandinavia

and on the continent east of the Franco-Germanic cultural frontier, rye is generally more important than wheat, excepting on the more fertile valley soils of South Germany and two small districts in Denmark and Sweden, and increases in importance to the east and north. West of that line rye is important only in the infertile highland of south central France. The same line approximately separates the areas to the east, in which potatoes are an important feed as well as food crop, and hence one of the major crops, from the western countries. In the latter although potatoes are important for food they are but little used for livestock and seldom constitute as much as ten per cent of the area in crops. In north-western Europe their place is taken, to some extent, by the root forage crops: turnips, mangels, beets, etc.

The subsistence form of this type covers a large part of northeastern Europe (pre-war Russia).¹¹ Rye is here particularly important, occupying as much as a third of the cropland. The peasant farmers have little or no wheat to mix in their black bread.¹² Potatoes, for man and beast, are of nearly equal importance, though the acreage is much less. Cash crops are provided in certain districts by the sugar beet—particularly in Poland—and flax, cultivated for its fibre, a high value product readily transported. In all areas made accessible by railroads, small amounts of rye, potatoes, and hogs are shipped out.¹³

In the commercial areas of this type agricultural practices are more advanced, more fertilizers as well as more machinery are used; hence crop yields per acre as well as per man are higher. Most farms produce some of all three major food groups for sale as well as to supply home needs. There are however significant differences between areas where crops form the major commercial products and those where meat and dairy products provide most of the farm sales.

¹¹ There is no accurate basis for the boundary between the subsistence and commercial areas. However the maps in Romer's *Atlas of Poland* (Warsaw 1916, 1930) showing surplus of grain production and distribution of livestock, together with current statistics and various other sources, confirm the impression obtained from cursory observation, namely, that little commercial agriculture was, or is, to be found east of the pre-war German frontier, excepting close to large cities. For example the striking boundary on Finch and Baker's 1913 map of swine remains as marked today. Hartshorne, R., "Geographic and Political Boundaries in Upper Silesia," *Annals Assoc. Amer. Geog.*, Dec. 1933, pp. 202-3.

¹² In the absence of available geographic literature on this area the reader is referred to the excellent description of the farms and local markets, in a district typical of this area, in the novel of the Polish Nobel Prize winner, Ladislav Reymont, *The Peasants*. New York, 1925. Translation in four volumes, each corresponding to one of the four seasons.

¹³ Data concerning the recent development of this area, particularly of the Soviet Union, are not available.

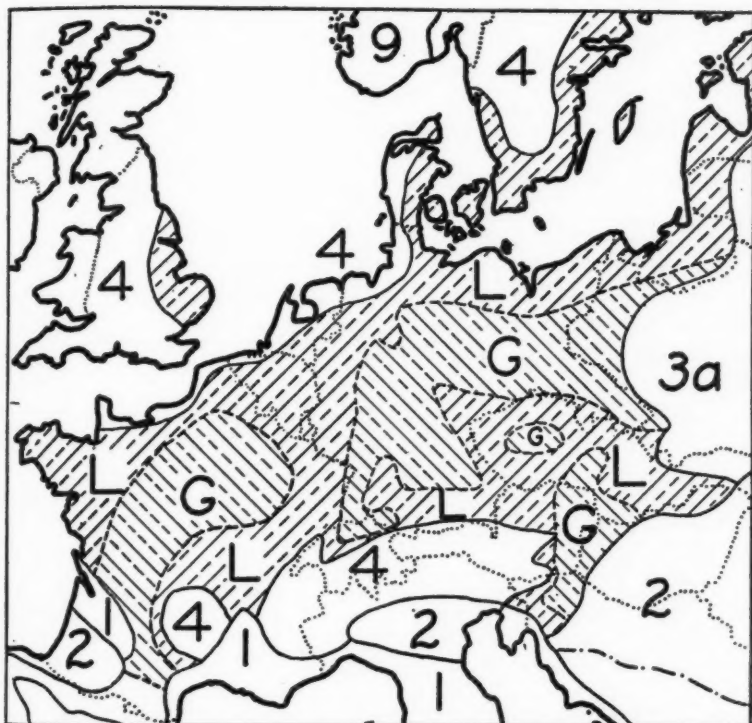


FIG. 6—Areas of Small grain and livestock farming in Europe. G—grains, potatoes, and other crops are commercially more important than livestock products; L—livestock products are commercially more important than crops. The boundaries are only approximate. The broken line in Yugo-Slavia is the approximate limit between subsistence farming to the south, and commercial farming to the north, in the corn, wheat, and livestock type. For the numbers 1-9 see Fig. 1.

On the more level but well-drained plains, the farmers concentrate on surplus grain production (Fig. 6). The bread-grains, wheat and rye, occupy more than one-fourth of the cropland, and hay and pasture amount to less than a fourth of the total crop-and-pasture land. Contrary to most generalizations of economists and geographers concerning land use, grain production rather than livestock is more important in regions close to the three largest cities in Europe. Apparently differentiation of land use within each European country depends more on variations in relief, soil, and drainage, than on distance from markets. As these countries contain no sub-humid areas of extensive grain farming, the competition of cheap grains from such areas can be met by high tariffs.

The proportion of livestock reaches its lowest in the center of the plain of northern France (Paris Basin) where there are less than 20 animal units per 100 acres of cropland (a low figure even by less intensive American standards). The chief commercial crops are wheat and oats, as well as vegetables, for the markets of Paris. Similarly on the plain east of Berlin, rye and potatoes are the principal commercial products, and hogs, rather than dairy cattle, the principal livestock product. In a few districts of particularly fertile soil, sugar beets constitute the chief cash crop, though occupying only 10 to 15 per cent of the cropland (Fig. 5a).

On the other hand, on the poorer drained lowlands and rough uplands the large amount of land usable only for hay or pasture has made more important the commercial production of livestock, particularly of dairy cattle. The land in hay and pasture is nearly equal to that in tilled crops, in some areas even greater. The bread-grains however remain important, occupying at least ten per cent of the crop-and-pasture land (Fig. 5b).

The specialized fruit or vineyard districts of western Germany and northern France, or the lake shores of the United States, are all too small to be shown on these maps, and are exceptional to the major regions.

An exceptional form of this type, in which wheat and rye are of little importance, is found in Denmark. The cultivated land is used almost entirely for feed crops for dairy cattle, notably root crops, barley and oats. The intensive cultivation of these crops together with the rich pasture and hay crops, and the high quality of the dairy herds and dairy practices have resulted in the most intensive dairy industry of any area in the world.¹⁴ Very likely much of the north German plain would show a similar development if tariff restrictions on imported grains had not maintained the bread-grains production. (The greater part of the dairy region of Denmark, like that in southern Wisconsin, is not included in the hay-pasture-dairy belt because of the importance of tilled crops).

IV. HAY-PASTURE REGIONS (FIG. 7)

Where the conditions suggested in Type 3—rough land, thin soil, poorly drained lowlands, cool and wet summers—are present to a high degree, most of the land is poorly suited to grain production but can be utilized for pasture and hay for dairy and meat animals. The regions import winter feed for the livestock as well as flour for the population. The proximity of large areas, thus handicapped, to the great industrial areas of Europe and North America, has made possible their development

¹⁴ Denmark produces 134 gallons of milk per acre of all land, 218 gallons per acre of cropland; in an intensive dairy district in Wisconsin, Calumet County, the corresponding figures are 92 and 170.

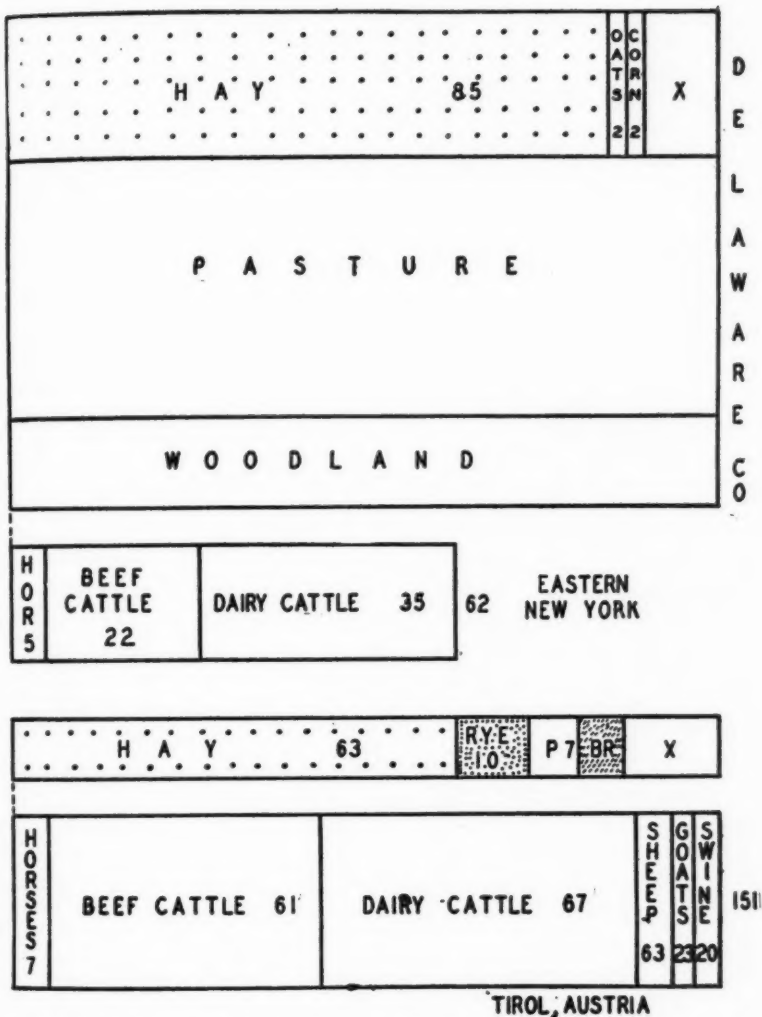


FIG. 7—Type areas of Hay and pasture, livestock farming. (Delaware County is in the upper Delaware River valley). P—potatoes. Note that in these two cases the livestock bars have been widened rather than lengthened to show the very large number of animals; the areas, rather than merely lengths, of the bars are proportional to those on the other graphs.

on such a specialized commercial basis. In consequence the wholesale abandonment of farms, in New York and New England for example, as a result of commercial competition of grain from better lands, has been much less than it otherwise would have been.

In many areas the permanent pasture constitutes much the largest part of the cleared land, and a large part of the land remains in woodland (Fig. 7a). Tilled crops are chiefly grown for dairy feed: silage corn, if it can be grown, oats universally, barley in most areas, and root forage in European areas. Buckwheat is locally important in certain districts in France and French Canada, and barley is used for food in Scandinavian countries, but usually the only important food crop grown is potatoes and these supply in some districts an important cash crop additional to the dairy products—in a few districts more important than the dairy products.

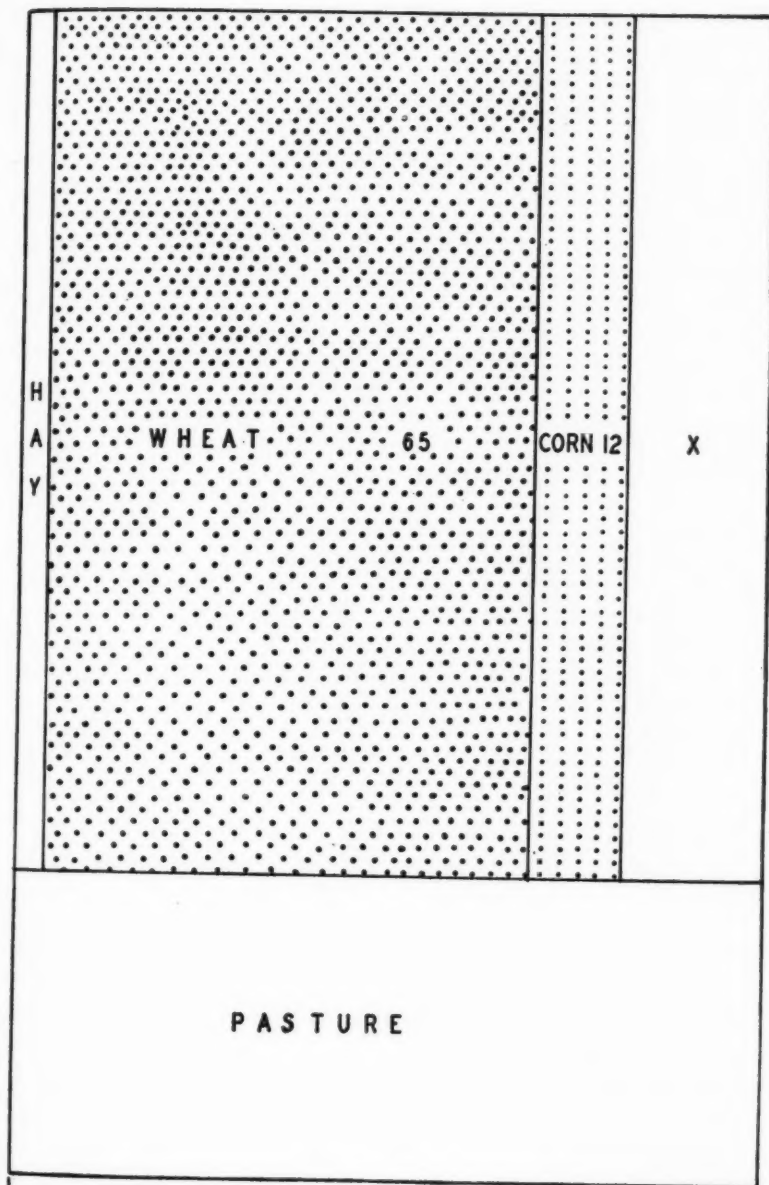
In Ireland and the greater part of Great Britain, beef cattle and sheep for mutton are more important than dairy cattle, but elsewhere in this type the reverse is the case; in most areas meat is produced chiefly as a by-product of the dairy industry. Where the district is producing butter or cheese, some calves and hogs are raised for market. Where the farmers are supplying the city markets with fresh milk, as in most of New York State, almost no meat animals are raised.

Transhumance in the Alpine areas and in the mountain region of Scandinavia has made possible the utilization of high mountain pastures for summer grazing. In these areas goats are also used for milk production, though they are everywhere of much less importance than the cattle. The product marketed from the mountain pastures is almost necessarily cheese (Fig. 7b). While the area of this type in North America includes most of the major dairy belt it does not include its southern margin, which because of the importance of field crops, especially of mature corn, is included in a previous type.

Two criteria were used for limiting this type: the area in hay and pasture is greater than that in tilled crops; and the area in wheat and rye is less than 10 per cent of the total crop-and-pasture land.

V. EXTENSIVE COMMERCIAL GRAIN FARMING (FIG. 8)

At the opposite extreme from the preceding type are the regions where farming is dominated by the commercial production, on an extensive scale, of one or two grain crops, particularly wheat. This rather simple type, one of the best-known of all our agricultural types, is found in the newly cultivated prairie areas of chernozem and chestnut soils, in western interior North America, Ukraine, North Caucasus, and Western Siberia.



H
O
R

CATTLE 8

SW
6

12

RICE COUNTY (CENTRAL) KANSAS

FIG. 8—Type area of Extensive commercial grain production.

Farming is highly commercialized with relatively small subsistence production; cash sales per farm in Montana-North Dakota even doubled those in Ohio in 1928, but this does not mean a greater farm income. Particularly characteristic are the large-scale methods of operation, the use of machinery for all field work, the minimum amount of cultivation, and the large size of farms, estates, or "collectives." In no other regional type of agriculture, excepting possibly tropical plantations, is the "factory" system of operation so developed. These methods, particularly in areas low in rainfall, produce yields of grain that are low per unit of land but high per unit of labor.

Wheat is almost everywhere the dominant crop, occupying anywhere between one-third and three-fourths of the cropland, and nearly all of it is shipped out of the region (except in Ukraine). Oats and barley are commonly minor crops, grown for feed for the draft animals and other stock, and also for shipment. Where severe winters prevent fall sowing of wheat, it is planted in the spring. In these areas fall-sown rye is grown as a cash crop and, in Russian areas, as a local food crop, and flaxseed is an important minor cash crop. In the winter wheat areas some corn is commonly grown, for feed, as a cash crop, and again in Russian areas as a major food crop of the peasants. In western Nebraska corn is an even more important cash crop than wheat.

Three criteria limit this type: farming is extensive, as shown by the size of farms and low yields per acre;¹⁵ livestock units are low, less than 20 per 100 acres of cropland; and the cultivated land is at least 20 per cent of the total area.¹⁶ For the area in eastern Europe however, no statistical basis was available.¹⁷

VI. TRUCK FARMS AND COMMERCIAL ORCHARDS (FIG. 9)

Market gardens supplying urban consumers with fresh vegetables are a familiar feature of the rural margins of all urban centers. The production of special vegetable products to be marketed at long distances, either fresh or conserved, is also scattered to a considerable extent through the regions of more general types of farming. In one area these truck farms together with similar commercial orchards are so highly developed—and more

¹⁵ To distinguish from the areas of intensive commercial corn production in eastern Illinois and eastern Nebraska, and that of intensive wheat production in the Paris Basin.

¹⁶ These limits correspond closely to that of the U. S. Census study of Farm Types which is based on the value of commercial grain products as compared with livestock products.

¹⁷ The boundaries there are based on various maps of Jonasson, Bowman, and others.

H 10	CORN 23	WHEAT 28	VEGETABLES 21	X 18
P A S T U R E				
W O O D L A N D E T C				

HOR 6	BC 6	DC 5	SW 19
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DORCHESTER COUNTY
MARYLAND

HAY 13	C 13	VEG 42	ORCH 10	X 23
P A S T U R E				

HOR 5	C 6	SW 29	18
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GLOUCESTER COUNTY
NEW JERSEY

FIG. 9.—Type areas of Truck Farms and Commercial Orchards. (The Maryland county is on the east shore of Chesapeake Bay; the New Jersey county is directly south of Philadelphia).

general types of farming so little developed—that the fruit and vegetable production is of paramount importance. This area is limited to the sandy-soiled outer margin of the Atlantic Coastal Plain, a narrow belt, except for the Florida peninsula (Fig. 2). Actually but a small part of the land is used for any kind of production, crop and pasture together amounting to less than half the area, in some areas far less than that. The truck farms and orchards present the paradox of highly intensive production on small units of land in the midst of widely unused areas. As a part of the intensive cultivation, commercial fertilizers in large amounts must be added to the sandy, humus-deficient soils.

In the portion from Virginia north, the greater part of the farm acreage is developed in corn, wheat, and livestock farming similar to that of

adjacent areas (Type 2), though much poorer. But the greater part of the farmer's labor is expended on, and his income derived from, the specialized fruit and vegetable products. The limit of this belt is based on the isopleth of 20 per cent of the cropland in fruits and vegetables, which corresponds closely with the boundary based on values.

More detailed maps would likewise recognize small districts of commercial fruit orchards and truck farms in various other parts of North America, as well as Europe.

TRACTS ALMOST UNFARMED

In both continents the northern areas of agriculture merge into the undeveloped forest areas, where handicaps of soil, relief, and drainage, as well as of climate, have prevented development. The limit on the maps (Figs. 1 and 2) is drawn where less than one-tenth of the land is in crops or pasture, including in this case woodland pasture. Similar almost unused and uninhabited forest districts are shown on the American map south of the outer limit; these will be readily recognized as areas of unusually infertile soil (Michigan, Pennsylvania, and Maine), or of mountain relief (in the Appalachians). Detailed statistics were not generally available for marking similar districts in Europe, notably in the Alps and Carpathians.

SUMMARY

The classification system presented provides a framework into which most of the forms of agricultural land use in the two continents may be fitted. Some such system is obviously of great value for *comparative* regional studies. The inclusion of separate regions in one type need not obscure their significant difference since any type may be readily subdivided. Rather one may say that by establishing criteria of classifying and putting lesser differences in their proper place, the system reveals essential cultural similarities between regions not commonly associated, *e.g.*, the Po Plain of Italy and the American Corn Belt.

Pursuing the technique first suggested by Jonasson and Baker, the criteria are objectively established and applied by *measurement*, a generally recognized requirement in other sciences. Further, the measurement is essentially geographic, *i.e.*, areal, being based on acreage rather than on production value. The criteria for separating the different farm types are based, in most cases, on the most important crops or products, determined commonly by areal extent. Intensity of production of certain crops, such as tobacco, is recognized, but where such a crop occupies less than 5, or even 10 per cent of the cropland, as in the sugar beet areas of Europe, it is not considered of major geographic importance.

The system has further been tested by applying it successfully to new areas of European culture in the Southern Hemisphere, so far as statistics were available, as in Australia, New Zealand, and the Union of South Africa. It should also be applicable in temperate South America, if the statistics are adequate.

The criteria used in this study may be briefly summarized in the following table. A generalized picture of the areal relations between the different

TABLE OF CRITERIA

	<i>Major Crop</i>	<i>Others</i>	<i>Limits</i>
All types			Crop-and-pasture land > 10% total area.
I. Mediterranean	wheat	barley, vines, fruits	Vine and sub-tropical tree crops > 15 % cropland.
II. Corn-wheat-livestock	corn	wheat, oats hay	Cotton < $\frac{1}{2}$ corn acreage. Tobacco < 20% cropland. Corn and wheat > 30%, corn alone at least 20% cropland.
III. Small grains-livestock	wheat rye	oats, barley potatoes, hay	Tilled crops > hay and pasture. Wheat and rye > 10% of crop-and-pasture land.
IV. Hay-pasture-livestock	hay	oats, barley, potatoes, silage corn	Hay and pasture > tilled crops. Wheat and rye < 10% crop-and-pasture land.
V. Extensive commercial grain	wheat	rye, corn, barley, oats	Livestock < 20 units per 100 acres of cropland. Large farms; low yields. Cropland > 20% total area.
VI. Commercial orchard & truck	Orchards and vegetables > 20% cropland.

types is shown in Figure 10. Figures 1 and 2 show the actual distribution of the types in Europe and North America.

The numerical limits between types are, of necessity, arbitrary, as in all systems of classification. Obviously they are subject to modification, but, as shown in several cases, such modifications would not change the

